ADOLESCENT PEDESTRIAN SAFETY AND ELECTRONIC DEVICES

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In the Name of Allah

Dedicated to the one who inspired me

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Published study

A version of the observation study used in Chapter 3 has already been published in the academic journal, Safety.

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Abstract

Mobile phones and other portable electronic devices may be common distractions to adolescent pedestrians that may increase their risk of traffic injury. The aims of this thesis were to examine the effects of portable electronic devices such as mobile phones on adolescent pedestrians' behaviour, attention to pedestrian scenes and risk-awareness. The study also sought to investigate age differences, gender differences, risk-taking, self-regulation and mobile phone experience to determine the issue of whether the pedestrian skills of some adolescents are more adversely affected by mobile phones than others. The issue of whether road safety messages for adolescent pedestrians using mobile phones could be improved was also considered. In order to accomplish the main aims of the study, several methods were used - namely: systematic review methods, observation methods, experimental methods, content analysis and interviews with adolescents to analyse their opinions on safety education messages.

The observation study reported in Chapter 3 investigated whether using mobile phones distracts adolescent attention while crossing the road. More than 3000 road crossings made by school-aged adolescents were observed. It was found that 31.37% of road crossings were made by adolescents with a phone or other device. It was also noted that the safety of adolescent pedestrians was affected by mobile phones and other devices. They looked left and right before crossing the road less frequently when they had an electronic device with them, particularly when looking at the screen and when texting or swiping. The rates of unsafe pedestrian behaviour in relation to technology use were similar for males and females. It was concluded that the safety of adolescent pedestrians is considerably affected by mobile phones and music-playing devices.

Experiments conducted with 50 participants aged from 11 - 17 years, reported in Chapter 4, used photographs of pedestrian scenes to investigate: (1) phone distraction for allocation of attention to features of pedestrian scenes and; (2) understanding of the dangers of different ways of using mobile phones at the roadside. The results showed that adolescents were able to avoid phone distractions and pay attention to the relevant features of a pedestrian scene in controlled experimental conditions. There were no age or gender differences and no significant correlation between attention to changes in pedestrian scenes, self-regulation, risk taking or experience of mobile phone ownership. Participants were aware of the risks of using a mobile phone at the roadside and they identified looking and listening to a phone as being more dangerous than holding it. However, their understanding of the dangers of phones for road safety was not always clear.

Road safety education that uses the information from these studies could help to improve adolescent pedestrian safety. Therefore, Chapter 5 examined 40 road safety websites and found that there were very few that included advice or information about mobile phone distractions for adolescent pedestrians. Chapter 6 examined adolescents' opinions regarding a selection of pedestrian safety information about mobile phones and what they thought would be a good way to inform other adolescents about the risks of using mobile phones when crossing a road. Participants advised that oral communication is the most effective way to increase road safety awareness about the use of the mobile phones while crossing the road or being around traffic.

In conclusion, it is clear that the road safety of adolescent pedestrians is affected by portable electronic devices. Going forward, therefore, initiatives such as road safety messages in an appropriate format that would appeal to and engage with adolescents are needed to reduce the risks of road traffic injury to adolescents.

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1.1.1 Adolescent pedestrian injury

The World Health Organization (WHO, 2019) reported that more than 3,700 people lose their lives in road accidents every day, while millions of people become disabled or injured from road accidents every year worldwide. These statistics include drivers, passengers, cyclists, motorcyclists and pedestrians. Pedestrians are a vulnerable group of road users, especially young pedestrians. In 2018, the WHO reported that about 26% of overall deaths per year were pedestrians. In the UK, 25% of all road deaths reported in 2014 were pedestrians. Further, in the UK, a rise of 1% in pedestrian injury was reported during 2016-2017. In addition, 28.65% of pedestrian casualties in 2017 were younger than 17 years of age. The UK Department for Transport (2018) reported that from a total of 23,805 pedestrian casualties in 2016, 25% were pedestrians aged between 0 and 15 years. Although the pedestrian injury rate fell by 6% between 2017-2018, the number of casualties was 22,397, Department for Transport (2019). Further, in 2018-2019, pedestrians represented 14% of overall casualties that involved the young population (Department for Transport, 2019). In addition, the WHO Report (2019) stated that males tend to have more injuries than females. In addition, the Department for Transport (2019) reported that the road traffic death rate for males was three times higher in comparison to that of females.

From these findings, it is clear that road traffic injury is a frequent cause of death and injury for all road users and there is a need to pursue research in this field to understand some of its possible underlying causes. Regarding pedestrians, the UK Department for Transport statistics (2017) stated that, 'the pedestrian failed to look properly' was the most frequent cause of pedestrian death or injury. In addition, the pedestrian failing to look properly was a contributory reason for road accidents in 39% of cases in which the pedestrian was not injured. The pedestrian failing to look properly may be caused by distractions. The focus of this thesis is on young pedestrians and the role of distractions in their pedestrian road safety.

This research focused on adolescents because they tend to be:

1. More actively engaged in negligent and risky behaviour in comparison with other age groups (Blackwell, Gardiner & Schoenebeck, 2016),
2. More active and avid users of portable electronic devices, such as mobile phones and electronic devices than other age groups (Oxley, Congiu, Whelan, D'Elia & Charlton, 2007).
3. Identified as a high-risk age group for road traffic injuries (Linne, 2014).
4. They are becoming more independent at this age range and unaccompanied by adults/guardians in pedestrian road-crossing environments.

1.1.2 Adolescent pedestrian distraction

Although traffic environments pose a risk for pedestrians at all times, the greatest risk is present when crossing a road. Crossing a road requires attention and the ability to avoid distractions. There are several sources of distraction that could affect adolescent pedestrian injury, such as thinking about something else, talking, or distracting features of the environment. Distractions may be visual, cognitive, auditory and/or manual (Levulytė, Baranyai, Sokolovskij & Török, 2017; Miao, Yang & Liang, 2016; Schick, 2014). Risky pedestrian behaviour associated with distraction could include impatience to cross the road, running rather than walking, listening to music while road crossing, chatting or playing games on mobile phones (Levulytė et al., 2017).

A rising cause of distraction for pedestrians is due to the increasing use of electronic devices such as mobile phones and portable music players. Mobile technology can potentially involve visual, auditory, manual and cognitive distraction. Adolescents are frequent users of mobile technology (Mireku et al., 2019), and mobile phones are known to be distracting to road users. Adolescents aged between 12-17 years are more frequent users of portable electronic devices while dealing with a traffic situation as compared to older people (Goldenbeld, Houtenbos, Ehlers & De Waard, 2012). Studies have found that text messaging raises the risk to pedestrians (Goldenbeld et al., 2012). Also, adolescents walking while listening to music were found to cross the road at a higher speed but were less likely to look in all directions before crossing the road (Goldenbeld et al., 2012).

Thompson, Rivara, Ayyagari and Ebel (2013) found that, in simulation-based studies, adolescent and college-age pedestrians experienced a higher number of accidents and close calls and waited longer to cross when distracted by mobile phones compared to undistracted pedestrians, irrespective of their experience with mobile technologies. These findings suggest that distraction, particularly the distraction of electronic devices, might be a cause of pedestrian injuries among adolescents. Although research on the effects of mobile technologies on those driving vehicles is increasing, there are fewer relevant studies on the effects of using portable electronic devices by adolescent pedestrians in relation to pedestrian injuries (Levulytė et al., 2017; Schwebel, Stavrinos, et al., 2012). People who use a mobile phone quite frequently and pay less regard to street rules are more prone to accidents at roads. These individuals are found to be more distracted as compared to an individual with less experience of using a phone (Stavrinos, Byington & Schwebel, 2011). Based on the discussion above, the role of mobile phones and other electronic devices in adolescent pedestrian road safety represents the principal investigative focus of this thesis.

Thomas et al. (2011) studied changes in adolescent cognitive function (n=236) over a one year gap using a computerised test battery. There was a relationship between the recorded use of mobile phones (sms and voice messages) and changes in cognitive measures. Response times dropped between the pre-test and follow-up for all adolescent groups but the improvement in response times was less pronounced for those with greater mobile phone use. Performance on Stroop tasks was not similarly affected though. The findings reveal that changes in some cognitive tests take place with a latency of as much as one year. Although there is a body of evidence to show that there is reduced attentional capacity during mobile phone use in adults (see above) these observations highlight that longer lasting effects might also impact significantly upon adolescents (Thomas et al., 2011). It remains to be seen whether these changes occurred as a natural regression to the mean or the direct impact of mobile phone use. Nevertheless this makes it imperative to investigate the behaviour of adolescents' mobile phone use while engaging in potentially risky activities like crossing roads as pedestrians. Their behaviour might be compromised by the longer lasting effects of mobile phones and their more immediate threat to attention.

Cinel et al. (2008) also studied the potential impact of acute exposure to the Radiofrequency Electromagnetic Fields (REF) generated by a mobile phone on a user. Six different test activities revealed that test performance of the participants was not affected significantly because of exposure to REF. The examination of the wider range of tasks revealed that the REF exposure does not create an impact on the cognitive functions (Cinel et al. 2008).

1.2 Pedestrian skills required to safely cross a road

Crossing a road is a complicated task that involves attention and an effective coordination between cognitive, perceptual and motor skills. The pedestrian needs to be able to understand locations that are safe or dangerous, detect the presence of traffic, coordinate information regarding auditory and visual timings and align their perception regarding safety with their actions when it comes to crossing the road. Several authors have described the key skills needed for crossing a road, especially in the context of learning and development (Chinn, Elliott, Sentinella & Williams, 2004; Tabibi, Pfeffer & Sharif, 2012). These include deciding where to cross, understanding risk, safety and danger, visual and auditory perceptual skills, attention, deciding when to cross, judging traffic gaps and time to contact, motor skills, coordination between perception, and action and awareness of one's own abilities. These skills lead to the integration of information from several sources in conjunction with the pedestrian's own motor skills. In this context, self-knowledge of movement capabilities in respect of time is also crucial (Oxley et al., 2007). Further, each of these skills needs to be developed and used together in rapidly changing contexts. A key process that underlies each of these abilities is attention.

Although there are numerous studies of children's pedestrian abilities, studies of adolescent pedestrians have focused more on attitudes and socially-influenced risk factors rather than on the lack or presence of basic skills (Tabibi & Pfeffer, 2007). The rest of this section will discuss some of the adolescent pedestrian abilities that have been studied and form a key part of the extant literature in this domain.

Child development studies have shown that deciding where to cross is difficult for children younger than seven years of age (Tabibi & Pfeffer, 2007), but approaching adult levels up to the age of approximately 12 years (Thomson et al., 1998; Tolmie, 2006). Tolmie (2006) found that adolescents between 11 and 15 years became more consistent at safe route planning as they got older. However, there is limited information in the prevailing literature regarding pedestrians over the age of 14 years (Tolmie, 2006).

According to Tabibi and Pfeffer (2003) time-to-contract judgement or ability to judge the gap between the pedestrian and the oncoming vehicle is one of the crucial skills required for pedestrians to determine whether they can safely cross the road or not. This requires pedestrians to focus their attention so as to determine the distance and velocity of oncoming traffic in relation to the crossing point, as well as estimating the amount of time it takes to walk across the road. Tolmie (2006) found improvements with age between 11 and 15 years in this area, but also observed that even adults found this particular skill difficult.

The decision to cross the road includes the cognitive processing of memory, central processing, information integration and attention. For instance, while crossing roads with two or more traffic lanes, a pedestrian is required to judge the decision after having memorised all relevant information coming from one direction and then simultaneously transferring the attention in the other direction. This indicates that short-term memory plays a crucial role in processing all information. This information can be about complex traffic, which is used by adolescents in taking decisions about road-crossing quickly. The ability to effectively process information is an important function of the brain required to make a safe judgement regarding crossing the road (Chaddock, Neider, Lutz, Hillman & Kramer, 2012; Zito et al., 2015).

Magar, Phillips and Hosie (2010) found that adolescents in the 11 to 17year old age group do not practice a strategic approach to utilising visual information while crossing roads. This might suggest a deficiency in attention (Magar et al., 2010) The authors also identified an alternative approach to this assertion and stated that adolescents are not aware of where to look to be able to decide on the safe point to cross the road. In a similar context, key research on visual, attention and perceptual skills of adolescents in crossing roads established that adolescents using a smartphone on roads were less competent than those that did not. This is most likely due to their lack of attention, which in turn puts them at risk as pedestrians. A key finding in this context was that the adolescents who were able to switch their focus in a prompt manner with a computer game were more likely to be attentive towards traffic while crossing the road (Ibrahim, Day, Hirshon & El-Setouhy, 2012; Magar et al., 2010).

Zito et al. (2015) commented that perceiving traffic either by hearing or seeing is important while crossing roads. In this regard, it is important that the pedestrian has a clear understanding of how and where the traffic moves. The pedestrian must be able to deploy his or her attention to acknowledge relevant auditory and visual cues, ignoring the unimportant ones (Zito et al., 2015). Chinn et al. (2004) explained that adolescents who were inattentive while crossing roads and had been involved in accidents had either failed to see the car or had not looked at all. Even when adolescents stopped at the roadside and looked at the cars, they only looked at the cars in isolation without paying much attention to the gaps and the link between them. According to Poudel-Tandukar, Nakahara, Ichikawa, Poudel and Jimba (2007), adults are less likely to stop before crossing the road because they are able to anticipate traffic gaps before reaching the road. In contrast, adolescents between the ages of 11 and 16 years are unable to apply such anticipation (Poudel-Tandukar et al., 2007).

Attention, distraction and road safety

As discussed in section 1.2, attention is important for crossing a road safely. This includes sustained attention (keeping a focus on something over a period of time), selective attention (focusing on something and ignoring distractions), and divided attention (paying attention to more than one thing at a time or multi-tasking). Each of these skills is useful for crossing a road safely.

Schwebel, Stavrinos, et al. (2012) have conducted research on attentional, visual and perceptual skills of adolescents on road-crossing skills. They found that in comparison to adults, adolescents were less competent in negotiating traffic situations because of underdeveloped abilities of perception and attention, which consequently raised their risk as pedestrians (Schwebel, Davis & O’Neal, 2012). Researchers have found that the ability to focus attention develops during childhood and that other types of attention continue to develop into adolescence (Cooley & Morris, 1990). The development of sustained attention is important for the optimisation of sensory processing which is critical for efficiently adapting behaviour in a changing world. Sustained attention is essential for adolescents in order to adapt efficient behaviours as well as to support "proactive" control for upcoming events (Thillay et al., 2015). For example, sustaining attention to a rapidly changing traffic environment is essential for adapting road crossing behaviour and predicting when it is safe to cross the road.

Crossing a road involves paying attention to many sources of information simultaneously (e.g., cars coming from different directions). Multiple Resource Theory explains the difficulties of paying attention to more than one thing at a time (multi-tasking) as being caused by one task interfering with another (Wickens, 1984, 2002, 2008). This builds on selective attention theories, such as Broadbent (1957), where attending to multiple tasks has practical and theoretical implications. The former has their origin in the predictions that the theory allows the human operator to perform in work environments where the workload involves multi-tasking. These tasks could include, for example, a secretary in a busy office, a driver in heavy traffic and the situation encountered by an aircraft pilot while landing a plane. The theoretical context emphasises that the importance of the concept of multiple resources lies in the potential to predict the dual task interference levels between the tasks that are to be performed consistently. This means being simultaneously consistent with the mechanism of neurophysiology associated with the performance of the underlying task (Wickens, 2002).

Wickens (2002) gives examples of driving while using a mobile phone and trying to read a map while driving. The cognitive resources needed to drive safely are also needed to pay attention to the phone or the map. This theory explains why it is more difficult to pay attention to a task if the second task relies on using the same type of mental resources as the first task. With regards to adolescent pedestrians, looking for traffic and looking at a phone at the same time requires using the same visual resources. Looking at the phone takes resources away from the pedestrian safety task of looking for traffic, and so neither of these two tasks can be done efficiently unless either the phone or the traffic is ignored. Therefore, the pedestrian's attention is distracted. Listening to the phone will be less distracting because it involves using different resources. Listening uses auditory resources while looking at traffic uses visual resources.

Crossing a road also involves adolescents deciding where to focus their attention and what to allocate their attention to. In section 1.2, it was discussed that adolescents are not always aware of where to look to be able to decide on the safe point to cross the road (Magar et al., 2010). A phenomenon of relevance to the allocation of attention to managing road traffic situations is change blindness (Magar, Phillips & Hosie, 2008), which in this context requires retaining and comparing visual information from one single glance to another separated by brief interval. The level of an individual's awareness is much more limited than intuitively believed by most people. A study by Rensink (2001) demonstrates that adults do not notice changes in a scene in a situation where they were shown two pictures alternatively, in a repeated manner and separated by a brief blank field or flicker that served as a hindrance to their attention. It was challenging to identify the substantial and repeated changes and the adults were usually unaware of any changes that were made in the pictures.

The finding of (Rensink, 2001) revealed that changes are more likely to be noticed if they are of central interest than the ones who do not perceive a complete and detailed visual presentation of the scene presented in the picture. Hence, individuals do not have a complete visual memory of a scene. This phenomenon has been identified as change blindness and can be relevant to understand the inability of the driver to notice the change in the road traffic environment. The study further emphasises that sometimes drivers might fail in identifying major changes that are crucial for road safety. These changes can include changes in the movement of the vehicles and their position on the road. This phenomenon of change blindness can also be applied to the case of pedestrians. The head movements of the pedestrian, made repeatedly from left to right, might involve significant changes that are often overlooked or not noticed by the pedestrians. Distractions are also caused by mobile phones that affect the ability of pedestrians to notice changes. The change blindness in this situation occurs due to a divided focus in a very complex environment. It is evident that changes to traffic lights may go undetected from the focus of an individual as they are not linked to the main task of looking at the mobile phone.

Sections 1.2 and 1.3 summarised some of the skills needed to cross a road safely, including attention and ignoring distraction. The next section introduces some aspects of adolescent development that are relevant to road safety.

1.3 Adolescent development relevant to road safety

According to UNICEF (2011) adolescence can be explained as the time of remarkable emotional and physical changes when young people aim to distinguish themselves from their parents. Internationally, the stage of 0-4 years can be referred to as early childhood, 5-9 years as middle childhood, and 10-19 years as adolescence (UNICEF, 2011). This section starts with a short discussion of adolescent brain development to explain some of the adolescent road safety behaviours and skills exhibited by this group. Additionally, more than one theory is needed to explain development relevant to road safety behaviour because of the various developmental changes that take place during adolescence. Section 1.3, therefore, will introduce Steinberg's theory of adolescent risk-taking as well as self-regulation theory.

Adolescent brain development and road safety

According to Boyer (2006) until the age of 20, the prefrontal cortex responsible for the complete range of executive functions is not entirely myelinated. These include working memory, planning and organising and impulse control. The memory system serves as temporary storage for management of the information required to conduct complex cognitive tasks such as learning and reasoning for making decisions about safe road crossing. The second function, planning and organising, involves devising an approach to undertake complicated tasks such as crossing a road while impulse control involves self-regulation, ignoring distractions and behavioural inhibition. The combined changes in the grey and white matter in the frontal, parietal and temporal lobes that lead to improved executive functions are associated with age differences in the competencies of adolescents. Development in visual, auditory, somatic and visuospatial systems improves metacognition or the ability to review mental operations. It also improves an ability to better use data for formulating problem-solving strategies in the age range between 13 to 17 years.

Growth in the prefrontal cortex helps in the development of new abilities to analyse data and develop a hypothesis, by the age of 17 to 21. This development helps adolescents to better analyse and perceive road traffic and eventually improve road safety.

Shulman et al. (2016) and Meir, Oron-Gilad and Parmet (2015) explained that the adolescent brain undergoes significantly dramatic changes in gross morphology. Imaging studies of human brain structure demonstrates that the loss of grey matter takes place throughout the cerebral cortex wherein reduction in grey matter portions in the temporal lobe and the dorsolateral prefrontal cortex occur during the late adolescent stage (Meir et al., 2015; Shulman et al., 2016). Human imaging has also revealed that white matter increases among adolescents in the cortical and subcortical fibre tracts and a higher level of myelination or both of these might occur, which in turn increases their overall ability to analyse, think and interpret situations, consequently improving the decision-making process of adolescents in crossing a road. Shulman et al. (2016) and Meir et al. (2015) also explain that adolescents activate similar affective and cognitive structures like adults, however, the magnitudes and temporal and spatial patterns of the levels of functional interconnectivity are different in comparison to adults (Shulman et al., 2016). The next sections will introduce Steinberg’s dual-processing theory which describes the role of brain development in adolescent risk-taking behaviour. Self-regulation theory will also be introduced.

According to Steinberg (2009), during the stage of adolescence thinking tends to be more abstract than concrete and gives adolescents the ability to consider numerous components that are necessary to make competent decisions at a given point in time. By the time adolescents reach the age of 16 years, the general cognitive abilities they possess, such as the ability to comprehend the outcomes of their decisions and the risks and benefits, are essentially similar to those of adults. However, according to Steinberg, the cognition and socio-emotional networks develop at different rates.

Regarding cognitive development, the study conducted by Steinberg (2009) on 935 individuals, aged from 10 to 30 years old, did not reveal any significant differences in the cognitive skills between adults and adolescents between the ages of 15-16 years. Further, Bonnie, Stratton and Kwan, (2015) asserted that although there are differences among individual adolescents and among adolescents of specific age groups, most adolescents tend to attain a level of cognitive maturity that is on par with that of adults by the age of 16 years. However, despite this cognitive maturity, some additional aspects of psycho-social maturity such as sensation seeking, peer influence, impulse control and reward-seeking continues to develop for further years.

Bonnie et al. (2015) also found that although adolescents may possess the cognitive ability to undertake healthy decisions, they are more prone to making risky decisions in comparison to adults. Even though adolescents of age ranging 15-16 years possess the ability to think in abstract terms and judge risky situations, they do not always employ these abilities adequately. In addition, the psychological factors affecting their behaviour such as peer pressure, impulsivity and emotional immaturity among adolescents can override their cognitive understanding regarding a risk.

According to Steinberg (2007), risk-taking is the outcome of a competition between socio-emotional and cognitive-control networks. These networks are more directive during the stage of adolescence and strengthen only gradually over a longer duration of time. In this context, Leshem (2016) highlights the subcortical structures that are responsible for the continuous development of self-control and associated higher order cognitive functions which eventually lead to adolescent vulnerability, and risky and impulsive behaviour. This behaviour can be further understood through the negative relationship between early maturation of socio-emotional networks and the considerably late maturation of cognitive networks. It generates a state of imbalance wherein emotions tend to override cognitive control mechanisms. This creates difficulty for adolescents to be able to control their stimulus-driven tendency, thereby minimising their ability to judge, capacity for reasoning and impulse control.

According to Pharo, Sim, Graham, Gross and Hayne (2011), risk-taking behaviour and decision making among adolescents are affected by the development of the limbic system and the prefrontal cortex. In light of the human neuroimaging studies and animal models, Pharo et al. (2011) argued that in conditions when an individual experiences high emotional arousal, adolescents tend to be inclined to engage in risky behaviour because their limbic system dominates. Their prefrontal cortical mechanism is not developed enough to assist them in suppressing or controlling their behaviour (Pharo et al., 2011). However, variations introduced with the changes in age help in creating a balance between the limbic system and the prefrontal cortex (Nakamura, 2016). These changes help in understanding why risk-taking behaviour is higher during the stage of adolescence. This can be identified as an essential factor relating to the self-regulation and risk-taking in adolescents and an underlying cause of pedestrian adolescent injuries (Pharo et al., 2011).

Smith, Chein and Steinberg (2013) further explained that the highest rise in risky behaviours might occur during the later stages of adolescent development than during pubertal change (Smith et al., 2013). On average, puberty takes place when antisocial peer influence happens to be relatively weak, and parental surveillance is strong. Consequently, although pubertal hormones might motivate an adolescent towards sensation-seeking, it is unlikely that entering the stage of puberty triggers recklessness (Smith et al., 2013).

Rahmini (2016) explained that adolescents tend to have a higher level of sensation seeking or a desire to experience a higher level of arousal or excitement. For instance, activities such as high-speed driving and the trance-like feeling associated with drugs give a higher level of pleasure to them (Rahmini, 2016). Sensation seeking demands recklessness and eventually leads to a significant rise in the rate of injuries and accidents among adolescents in this age group. For instance, there is a higher tendency among adolescents to drive at speed and not use seat- belts in comparison to adults. In addition, Steinberg (2009) also states that such risky behaviour is more likely to occur when adolescents are with their friends. The central argument raised by Steinberg’s Theory is the focus of two processes - the socio-emotional and cognitive. Here, socio-emotional development focuses on taking risks while being in the company of friends or peers. This is because of changes to the dopamine pathways and oxytocin receptors. This indicates that they receive higher pleasure by indulging in risky behaviour while being in the company of friends. Therefore, it is not necessary that they feel safe but that they have the desire to draw pleasure from sensation-seeking or risky behaviour.

Byck, Swann, Schalet, Bolland and Mustanski (2015) further asserted that risky behaviour tends to be more common among adolescents because it helps adolescents gain acceptance among their peers and establish autonomy from parents and other authority figures. The same has also been suggested by Steinberg's theory in that adolescents who desire higher popularity are more likely to engage in risky behaviour in comparison to peers who do not desire popularity. Immaturity in the pre-frontal cortex and associated structures of the brain also are associated with the higher level of sensation seeking among adolescents in comparison to adults.

According to Steinberg, risk-taking is the outcome of a competition between the socio-emotional and cognitive-control networks. However, there might be additional factors influencing the decisions and behaviour of adolescents on the roads. In this regard, Self-Regulation Theory (SRT) developed by Baumeister, Vohs and Tice (2007) can also be explored to understand additional aspects of adolescent behaviour. This theory explains the components and processes that are involved in the decision-making process of individuals their thoughts, feelings. According to Baumeister et al. (2007), the critical components of SRT are standards defining desirable behaviour, motivation to follow the rules, monitoring the thoughts and situations that might influence breach of rules, and willpower to allow the internal strength to ensure that the urge of desire is controlled. According to Magar et al. (2008), this behavioural trait and self-regulatory control indicates the engagement of adolescence in activities involving risk. The study was conducted by Magar et al. (2008) on adolescent students to measure emotional regulation, cognitive regulation and risk-taking. The findings revealed that there is a positive correlation between poor cognitive self-regulation and endorsement of risky activities. The research asserted that indulgence in inadequate emotional regulation predicts higher participation in risky behaviour, which might also include activities such as the use of mobile phones while crossing roads (Magar et al., 2008).

As the adolescent brain is still undergoing development it is likely that will be implications on behaviour that can potentially make adolescents more vulnerable in certain situations particularly with respect to the brain regions associated with processing emotional information (e.g. Steinberg, 2008). Adolescents are potentially more prone to activation of the subcortical brain systems in comparison to adults in the presence of emotional stimuli. This tends to have lesser potential to activate multiple cortical or subcortical areas concurrently. These findings thereby, suggest limitations in synchronisation of cognition and affect in comparison of adults (Steinberg, 2008). Casey, Jones and Hare (2008) further support these findings and explain that in contrast to the linear development in age in respect of impulse control, risk-taking can be examined to be higher in adolescents concerning the childhood and can also be observed to be closely associated to the subcortical systems. The examination of the human imaging studies reviewed in this literature also indicates a rise in subcortical activation while making choices involving risks and emotional processing information.

1.4 Adolescent injury prevention

Road traffic accidents are a serious public health issue that can cause fatal injuries and deaths (Joshi, 2019). The five broad classifications of accidents can be identified as unplanned and unexpected events that carry a serious risk of ill health, injury, damage to the environment, loss of life and property or any other any combination of these risks (Croner-I, 2020). Therefore, accident prevention can be defined as plans, arrangements and tasks undertaken to prevent or evade an accident before its occurrence (Willacy, 2019). Also, road safety implies the adoption of all methods and measures that can help road users gain security from the risk of getting injured or loss of life. The best measures in this regard are ensuring sustainable prevention of fatal crashes or death (Rudin-Brown & Jamson, 2013). Safety refers to following all measures to reduce or prevent risk and precautions taken while walking or crossing a road (Elvik, Høye, Vaa & Sørensen, 2009).

Providing all necessary education to adolescents regarding the rules for a safe pedestrian can help in increasing road safety awareness (Rudin-Brown & Jamson, 2013). Correct and efficient programs created for road safety education can be highly useful in saving the lives of people and preventing injuries and accidents (Luong, 2018). Road safety education can be understood as an education program offered to adolescents in community and formal education settings such as primary and secondary schools to make them aware of road safety (Luong, 2018). Road safety education plays a highly significant role in forming the behaviour and attitude of children and young people. It thus helps in making them responsible passengers, drivers, cyclists and pedestrians (Luong, 2018). Since adolescents and children form the future of a country, they must practice road safety measures to ensure that they progress safely to adulthood. As a student, they can gain essential information and knowledge regarding road safety and incorporate this into their daily practices, which in turn could help give them a better life and future.

Road safety education focuses on the five Es, which aim to increase road safety and security. These are Enforcement, Encouragement, Evaluation, Education and Engineering (Riaz et al., 2019). They have been recognised as an effective measure to spread awareness regarding road safety (Riaz et al., 2019). There are three chief pillars (Riaz et al., 2019) involved in road safety: to raise the knowledge and awareness of traffic situations and rules, offer training to improve skills and strengthen positive attitude among adolescents towards safety, and improve risk awareness and security of the users. It is essential to customise road safety education so that it is congruous with the experience and age group of the students (Riaz et al., 2019).

There are several studies linked to child and young adolescent road safety education. These studies have different aims, but they all focus on children and adolescent road safety. One aspect that it is important for adolescents is to have detailed knowledge regarding road safety so as to reduce road accidents. The Youth and Road Safety Action Kit is regarded as a useful instrument that can be used by adolescents to gain awareness and knowledge about road safety irrespective of their location, experience or background. This initiative consists of three parts (Yours, 2012). The first part offers information regarding the global road safety crisis focusing mainly on the youth. The second element guides how the information provided can be used and implemented for personal safety on roads. The third and final aspect provides relevant briefings on processes and actions that can be incorporated to spread awareness of road safety (Alonso, Esteban, Montoro & Useche, 2017; Yours, 2012).

A study by Richmond, Zhang, Stover, Howard and Macarthur (2014) focused on determining the effectiveness of bicycle skills training programmes in reducing bicycle-related injuries amongst children and the youth. The study was based on database research, where 16 databases were systematically checked for studies about children under 19 who participated in interventions related to bicycle skills and safety education. The outcomes measured included: knowledge, behaviour, attitudes and injuries. The quality of the data was evaluated, and the study concluded that educational skills training bicycle programmes may increase knowledge of cycling safety and reduce accidents cases.

A study by Schwebel, McClure and Severson (2014) was oriented towards testing the efficacy of virtual reality for training child pedestrians in safe street-crossing techniques and behaviour. This study used a sample of four groups of 60 children aged between 7-9 years. The first group received training in an interactive, immersive virtual pedestrian environment. The second group received pedestrian safety training via video and computer strategies, while the third group received individualised behavioural training at street locations. The fourth and final group served as the control group of non-contact. The study observed that virtual reality offers training through unsupervised practise without risk.

Chuah, Chen and Teh (2009) applied a virtual educational environment for the teaching of road safety skills to school students aged between 12- 14 years old in Malaysia. The study’s aim was to use virtual reality as a tool to assist the student in learning and in simulating situations which are considered to be as very hazardous to practice in reality. This paper described the system design of the virtual reality-based learning environment known as Virtual Simulate Traffics for Road Safety Education (ViSTREET) and its different features. The study demonstrated that virtual reality is a potential instructional tool for providing simulated training and skills teaching in dangerous or logistically impossible situations such as heavy traffic. Therefore, virtual reality is eminent in prevention training as well as emergency or disaster management. One area of concern in which virtual reality can offer a plausible solution is road safety education that is often confined to the use of verbal teaching and printed materials where it may be impractical to carry out any road crossing exercises on real roads.

This section presented some road safety education tools and kits. The evaluation for the effectiveness of these tools and kits by the researchers were also discussed. However, the examination of the literature in this area has revealed an absence of relevant studies on road safety education for adolescent pedestrians in the context of mobile phone usage. This indicates a pertinent gap in the prevailing literature and highlights the need for further research on the kind of messages that can be developed to motivate and educate young people regarding the practice of road safety behaviour.

1.5 Research rationale, questions and aims

It can be found from the above introduction; it is clear that a common distraction for adolescents while crossing roads is the use of portable electronic devices. Using them tends to divert the physical, cognitive, auditory and visual senses of an individual during the road- crossing activity (Nasar & Troyer, 2013).

The review of research literature to be presented in Chapter 2 will show that there are relatively few studies specific to adolescent pedestrian mobile phone distraction. This thesis investigates the attention and distraction associated with mobile phones in pedestrian contexts. Also, there are few studies that investigate gender and age differences in pedestrian phone distraction. Research presented in section 1.1 found that males have more road accidents than females, so gender differences in pedestrian phone attention and distractions were investigated in this thesis. Also, the theory of risk-taking described in this chapter would predict age differences relevant to risks due to differences in cognitive and socio-emotional development. Therefore, age differences in the cognitive task of pedestrian decision-making were investigated. Self-regulation theory was introduced in this chapter as the basis for investigating whether self-regulation was associated with mobile phone risks to pedestrians. Finally, the role of road safety messages was investigated to ascertain whether a need for relevant road safety education exists and what type of educational message would be helpful for adolescents.

Based on the examination of the prevailing literature, along with the relevant theories and concepts associated with adolescent behaviour and cognitive development, it is evident that there is a dearth of studies devoted to examining the road safety behaviour of adolescents. Additionally, there is a significant lack of research on the use of mobile phones by adolescents while crossing roads, indicative of a major gap in the prevailing literature. There are also few relevant studies on safety research and education interventions developed for the use of mobile phones while crossing roads, which represents a major gap in existing knowledge. In order to address this gap, this research seeks to examine the effects of mobile phone distractions on the adolescent pedestrian. For this purpose, the proposed research will utilise the observation method, experiment, content analysis and evaluation of road safety education materials.

Additionally, evidence reveals that 11-year-old pedestrians are three times more vulnerable to being the victim of road accidents while crossing roads because this is the age when adolescents normally receive their first mobile phone and, therefore, they tend to use it very heavily (Henley, 2013). More than 45% of teenagers are distracted while crossing roads because they are occupied in reading or sending texts, talking on the phone or listening to music. Another recent survey in the UK revealed that 27% of motorists stated they had almost hit a pedestrian who was using their mobile phone while crossing the road. In contrast, 85% revealed that they had almost hit pedestrians too occupied on the phone. Pedestrian fatalities increased in the UK by 12% or from 398 in 2013 to 446 in 2014 (Kim, Min, Kim & Min, 2017; Stevenson et al., 2016). Therefore, it can be inferred that the issue of mobile phone usage in adolescents while crossing roads is a trend that is increasing, and that there is an absence of adequate literature and research in this area that has explored measures to address this issue. Based on this rationale and research gap, this research seeks to investigate the following research questions and related aims.

Research Question 1: What are the effects of mobile phones on adolescent pedestrians?

Aim 1: To investigate the effects of utilising portable electronic devices, such as a mobile phone on adolescent pedestrian behaviour.

Aim 2: To investigate the effects of utilising portable electronic devices, such as a mobile phone on adolescent pedestrian risk awareness and pedestrian attention/distraction.

Research Question 2: Are some adolescents affected more than others?

Aim 3: To investigate the relationship between self-regulation, risk taking and use of portable electronic devices in a pedestrian decision-making context.

Aim 4: To investigate age, gender, and mobile phone experience on adolescent pedestrian decisions.

Research Question 3: How can road safety education for adolescent pedestrian mobile phone users be improved?

Aim 5: To investigate whether existing road safety education training includes information about mobile phones and other electronic distractions.

Aim 6: To investigate adolescents 'opinions about pedestrian safety education.

1.6 Overview of the thesis

Chapter 1 This chapter identified adolescents' use of portable electronic devices while crossing roads. Its use tends to divert the physical, cognitive, auditory and visual senses of an individual during the traffic. This chapter presented rates of adolescent pedestrian injury and the role of distraction in pedestrian injuries. It identified mobile technology as a distraction to pedestrians. An overview of some of the skills needed to cross a road safely was introduced, in particular, attention, distraction and attention theories. Adolescent development relevant to road safety was introduced with respect to brain development, risk-taking and self-regulation theory. Injury prevention for adolescent pedestrians regarding mobile technology was introduced.

Chapter 2 This chapter presents a review of research on adolescent pedestrian and mobile phone use, using systematic review methods. The aim of this chapter is to critically analyse and or evaluate the published research studies that have investigated the effects of using portable electronic devices, such as a mobile phone, on adolescent pedestrian behaviour.

Chapter 3 In this chapter, observation method used to investigate adolescent pedestrian behaviour when using portable electronic devices, such as a mobile phone by examining the number of adolescents crossing the road with a phone or another electronic device. Further, it also aims to conduct a more detailed observation of road-crossing behaviour in relation to different types of mobile phone use or another electronic device. The chapter also involves a comparison of adolescent pedestrians with electronic distractors and those without. The comparison is made regarding listening, looking and texting, between males and females, as well as individuals and groups crossing the roads.

Chapter 4 Using experimental and questionnaire methods, this chapter investigates adolescents' risk-awareness, self-regulation, decision-making and attention in relation to pedestrian mobile phone use. The main objective is to add to the observation study findings which describe road safety behaviour in the natural environment and do not explain reasons for behaviour or development of associated skills. This chapter explores the role of factors such as age, gender, and experience of using mobile phones on the decision making/risk awareness of adolescents regarding pedestrian behaviour.

Chapter 5 describes an investigation of road safety websites for reducing traffic-associated harm to young people. The aim of this chapter is to investigate whether any advice or information on mobile phone use while crossing the road is included on non-UK government agencies and UK government agencies' online platforms, aimed at educators, parents, teachers and adolescents.

Chapter 6 investigates the opinions of adolescents about the effectiveness of pedestrian safety education interventions on adolescent use of portable electronic devices in a pedestrian context. This may be very useful for the design of road safety training and the ideas provided by young people for designing road safety training could support institutions such as schools and road safety educators.

1.7 Importance and contribution of the research

The importance of this study is provided through the following contributions:

(1) This is one of the few studies to investigate the effects of electronic devices specifically on pedestrian adolescent behaviour in the UK using multiple research methods.

(2) The results of this study will provide important information about the impact of electronic devices on adolescents' pedestrian behaviour.

(3) This study is one of few that provide a background on how pedestrian adolescents can be advised of the harmful use of electronic devices such as mobile phones on the road from the viewpoint of adolescents themselves, with the aim of reducing accidents and injuries.

Chapter 2. Review of research on pedestrian safety and electronic device distractions: A systematic review

2.1 Introduction

The previous chapter identified that one of the most common distractions for adolescents while crossing streets is the use of portable electronic devices. Its use tends to divert the physical, cognitive, auditory and visual senses of an individual when confronted with traffic. This chapter presents a review of previous studies on adolescent pedestrian safety and mobile phones. The examination of the previous studies will help determine the gaps in the extant literature, such that the researcher will seek to address them through this thesis.

This review addresses the first research aim and seeks to assess the current state of knowledge on the effects and implications of portable electronic device usage (i.e. mobile phones) on the behaviour of adolescent pedestrians.

2.2 Methods

This systematic literature review was conducted according to PRISMA guidelines and procedures (For example see; Boland, Cherry & Dickson, 2017; Booth, Sutton & Papaioannou, 2016; Gough, Thomas & Oliver, 2012).

2.2.1 Search strategy

The following search terms were used to find relevant articles: Pedestrian OR pedestrians OR walk OR walking OR cross, crossing. And mobile phone OR "smart phone” OR “cell phone” AND adolescent*, adult*, teen*. This search strategy was applied to the following databases:

1. General Databases: Scopus
2. Department related databases: Healthcare- Medline
3. Subject related databases: Psychology- Psyc Article, PsycINFO
4. Specialised databases: Road safety- Safety Lit

The abovementioned electronic databases were selected because they comprise journals that have published research papers based on the research topic as well as having been utilised in other reviews. Moreover, specifically as it relates to the database, Safety Lit (number 4), this gives cost-free, easily accessible, comprehensive and internet-based journal articles specifically about safety problems raised in distinct nations and professional settings (Safety Lit., 2020). Electronic sources from database such as Pope, Schwebel, Shen and Stavrinos (2018) have been selected for this study.

2.2.2 Inclusion and exclusion criteria

In terms of inclusion/exclusion criteria, studies that published peer reviewed reports of empirical research were included. Books, book chapters, theses and conference papers were excluded. Only studies written in the English language were included. The date range used for the search strategy was limited to include articles published from 2000 to 2018.

The topic focus for articles that were included was linked to the distractions caused by using mobile devices and headphones only, and not those studies that focused on distractions caused by devices such as iPads or iPods, handheld devices, MP3s and MP4s. The studies selected also focused on the risks to the pedestrian while using mobile phones or headphones. Studies with children, adolescents or high school students and adult participants were included. Studies of cognitive distractions, visual distractions and auditory distractions were included. Studies were also included that linked to information on different pedestrian variables such as time left to spare, missed opportunities, attention to traffic and hits or close calls (see Table 2.1).

Table 1: 2.1 Inclusion and exclusion criteria

	Inclusion Criteria	Exclusion Criteria
Language	• English Language	• Language other than English
Sources of Data	• Journals on the effects of mobile phones on adolescent pedestrians • Academic peer-reviewed publications on the effects of mobile phones on adolescent pedestrians	• Non-academic publications • Scholarly publications on topics other than the effects of mobile phones on adolescent pedestrians • Academic peer-reviewed articles or journals not on the effects of mobile phones on adolescent pedestrians
Types of Studies	• Studies having well defined and justified methodology • Studies involving thematic analysis or interview analysis • Valid studies with credible sources and references	• Papers lacking credible references and structure • Online essays, thesis and blogs on the effects of mobile phones on adolescent pedestrians
Websites and Databases	• Scopus • Medline • Psyc Article, PsycINFO • Safety Lit	• Blogs • Educational dictionary • Wikipedia • Academic essays • Books • Theses • Conference papers

Time of publication	• 2000-2018	• Before 2000
Road user	• road user a pedestrian (walking or crossing)	• Driver • Bicycle.
Devices	• the pedestrians using mobile phone and/ or headphones	• iPads • iPods • MP3s • MP4s
Outcomes	• the main result contains unsafe crossing behaviours? Such as not looking left and right before crossing)	• the main result does not contains unsafe crossing behaviours? Such as not looking left and right before crossing)
Type of distraction	• calling, texting, using headphones or playing a game	• not mentioned any type of these distractions • mentioned other types of distractions such as eating or drinking only.

2.2.3 Primary and secondary outcomes

The primary outcome of the studies in this review was the distraction of pedestrian behaviour while using mobile phone compared to non-mobile phone users. An additional secondary outcome showed comparisons between mobile phone user pedestrians according to age or gender. Comparisons among different behaviours were also extracted.

Table 2: **2.2: Primary and secondary outcomes**

Assessment	Answers	
	Included papers	**Excluded Papers**
1-**Road user** Is the road user a pedestrian (walking or crossing)?	**yes (…)**	**no (…)**
2-**Devices** Are the pedestrians using mobile phone and/ or headphones?	**yes (…)**	**no (…)**
3-**Outcomes** Does the main result contain unsafe crossing behaviours? Such as not looking left and right before crossing)	**yes (…)**	**no (…)**
4- **Type of distraction** Is it calling, texting, using headphones or playing a game?	**yes (…)**	**no (…)**

2.3 Quality assessment of the selected studies

Evaluation of quality of the research is an important step of the systematic review. The selected studies were assessed for both quality of methodology and systematic biases that could have affected results.

The selected studies were assessed for quality of methodology and reporting using 11 criteria developed by (Kmet, Cook, & Lee, 2004). The assessment criteria for the quality of the research was based on the following questions:

1. Was the research question/objective sufficiently described (title, abstract, introduction)?

2. Was the study design evident and appropriate (method, procedures)?

3. Was the method of participant/comparison group selection or source of information/input variables described and appropriate (random, without bias)?

4. Were participant and comparison group (if applicable) characteristics sufficiently described (size, age, gender)?

5. Was the outcome and (if applicable) exposure measure(s) well defined and sufficiently robust to detect measurement/misclassification bias (results)?

6. Were the means of assessment reported (measures, tools)?

7. Was the sample size appropriate?

8. Were the analytical methods described/justified and appropriate?

9. Was some estimate of variance reported for the main results?

10. Was there any control for confounding factors? Was there sufficient detail in the reporting of results?

11. Did the results support the conclusion?

These criteria were used for studies of different designs and the scores were calculated as a percentage by dividing the total score (out of 22) by 100, by collecting the score from answering the criteria questions which were as follows: Yes= 2, Partially=1, No=0. These can be seen from the results of the quality assessment of the studies in Table 2.3.

Table 3: 2.3 Quality assessment of the studies

study number	criteria 1	criteria 2	criteria 3	criteria 4	criteria 5	criteria 6	criteria 7	criteria 8	criteria 9	criteraia 10	criteria 11	score	percenteg
study 1 Stavrinos et al.,2011	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	22	100%
study 2 Stavrinos et al., 2009	yes	yes	yes	yes	yes	yes	partially	yes	partially	yes	yes	20	90%
study 3 Neider et al.,2011	yes	yes	partially	yes	yes	yes	partially	yes	no	partially	yes	17	77%
study 4 Nasar.,2008	yes	yes	yes	partially	yes	yes	yes	no	no	partially	yes	16	72%
study 5 Tapiro et al., 2016	yes	yes	yes	partially	yes	yes	partially	yes	yes	partially	yes	19	86%
study 6 Neider., 2010	yes	yes	partially	partially	yes	yes	partially	yes	no	partially	yes	16	72%
study 7 Schwebel et al., 2012	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	20	90%
study 8 Hatfield & Murphy, 2007	yes	yes	partially	yes	yes	yes	yes	yes	partially	partially	yes	18	82%
study 9 Byington et al., 2013	yes	yes	partially	partially	yes	no	yes	no	no	partially	yes	13	59%
study 10 Thompson et al., 2013	yes	yes	yes	partially	yes	yes	yes	partially	no	partially	yes	18	82%
study 11 Basch et al.,2015	yes	yes	partially	no	yes	yes	yes	no	no	no	yes	13	59%
study 12 Hyman et al., 2010	yes	yes	yes	partially	yes	yes	yes	no	no	partially	yes	16	72%
study 13 Licence et al.,2015	yes	yes	partially	yes	yes	yes	partially	yes	partially	partially	yes	18	82%
study 14 Bungum et al.,2005	yes	yes	partially	partially	yes	no	yes	yes	no	partially	yes	15	68%
study 15 Banducci et al.,2016	yes	yes	partially	no	yes	yes	partially	no	no	partially	yes	13	59%
study 16 Violano et al.,2015	yes	yes	partially	partially	yes	yes	yes	no	no	partially	yes	15	68%
study 17 PAI, C. 2017.	yes	yes	partially	no	yes	no	yes	yes	no	partially	yes	14	66%
study 18 Pešić et al.,2016	yes	yes	partially	partially	yes	yes	yes	yes	partially	partially	yes	18	82%
study 19 Lin et al.,2017	yes	yes	partially	partially	yes	yes	partially	partially	no	partially	yes	15	68%

2.4 Results

As a first step, the initial 138 search results were found independently by using the inclusion/exclusion criteria to screen the titles and abstracts. After removing 79 duplicates, 59 manuscripts were retained, full texts were reviewed, and full eligibility criteria were applied. From these 59 manuscripts, a final total of 19 full texts articles were selected as shown in the PRISMA flowchart (figure 2.1).

2.4.1 Cultural context

The research included in the review was conducted in a limited range of countries: USA (n = 13), UK (n = 1), Taiwan (n = 2) Serbia (n = 1), Israel (n = 1) and Australia (n = 1).

2.4.2 Research methods

The studies included examined the effect of mobile technology using an experimental interactive virtual environment. The 10 studies chosen for the review used methods such as simulation as well as real trials (Banducci et al., 2016; Byington & Schwebel, 2013; Licence, Smith, McGuigan & Earnest, 2015; Lin & Huang, 2017; Neider et al., 2011; Neider, McCarley, Crowell, Kaczmarski & Kramer, 2010; Schwebel, Stavrinos, et al., 2012; Stavrinos, Byington & Schwebel, 2009; Stavrinos et al., 2011; Tapiro, Oron-Gilad & Parmet, 2016). Seven studies were observational. These employed naturalistic observation, a case-control design, and a controlled field study, focusing on actual pedestrian behaviour in real situations (Basch, Ethan, Zybert & Basch, 2015; Bungum, Day & Henry, 2005; Hatfield & Murphy, 2007; Pai, 2017; Pešić, Antić, Glavić & Milenković, 2016; Thompson et al., 2013; Violano, Roney & Bechtel, 2015). Only 2 of the studies contained both methods: experimental and observational, (Hyman Jr, Boss, Wise, McKenzie & Caggiano, 2010; J. Nasar, Hecht & Wener, 2008); see Table 2.2.

2.4.4 Type of distraction

As seen in Table 2.2, 18 studies investigated the effects of cognitive distraction (17- talking or holding a conversation, 1-using the internet), 7 investigated visual distraction (texting), and 9 investigated auditory distractions (6-listening to music, 3-wearing headphones

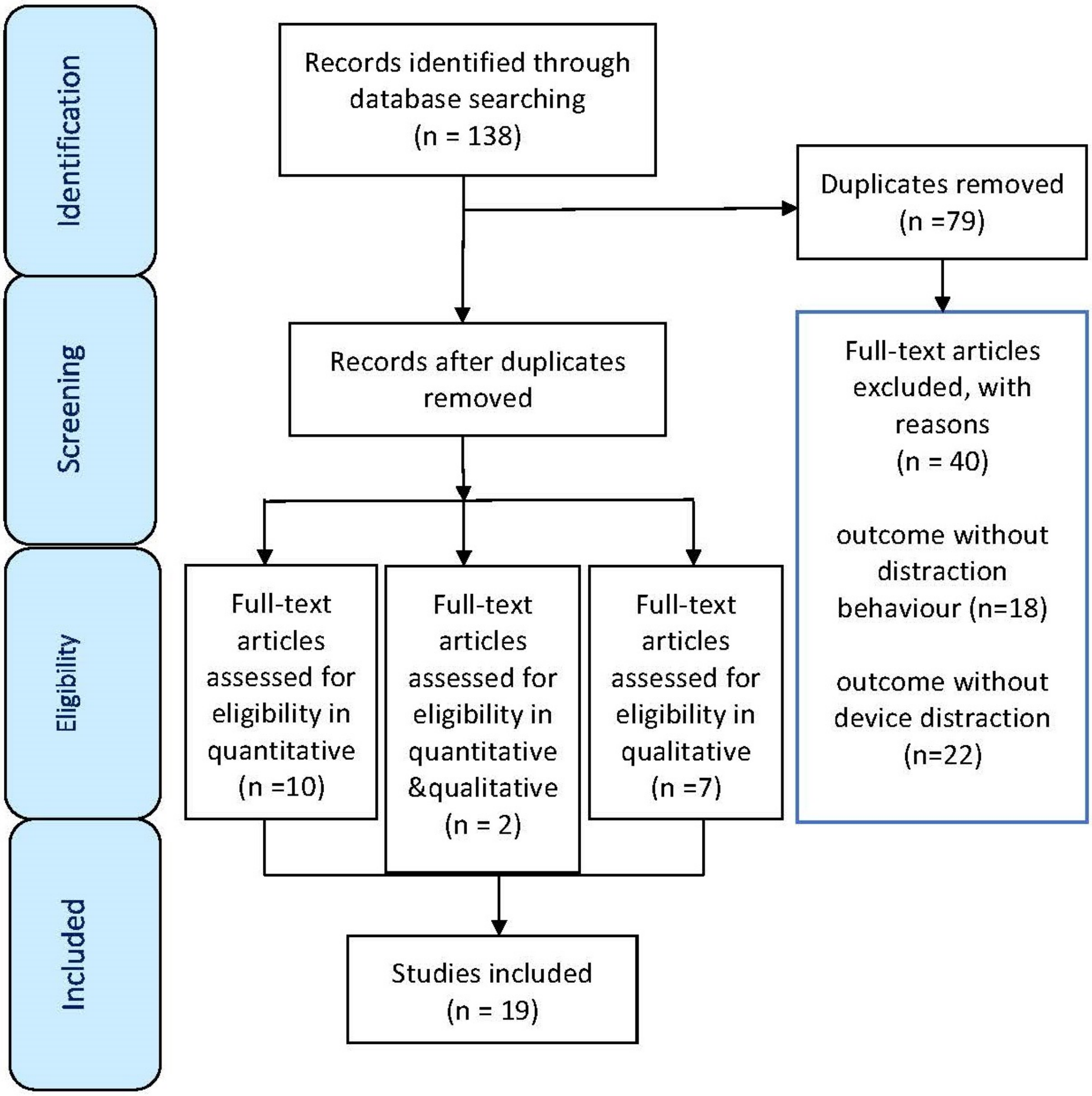


Figure 1: 2.1. PRISMA (preferred reporting items for systematic review) flow chart

2.4.5 Effects of electronic devices

Based on the literature reviewed, the use of mobile technology led to cognitive distractions of adolescent pedestrians looking right and left, more slowly walking and getting diverted from their way (Banducci et al., 2016; Byington & Schwebel, 2013; Licence et al., 2015; J. Nasar et al., 2008; Neider et al., 2011; Neider et al., 2010; Schwebel, Davis, et al., 2012; Stavrinos et al., 2011). Pedestrians tended to look left and right fewer times before crossing, be less attentive to traffic, leave less safe time between their crossing and the next arriving vehicle, experience more collisions and close calls with oncoming traffic and wait longer before beginning to cross the street while talking on their mobile phone. Adolescents faced difficulties while using mobile phones as they crossed roads more slowly and without waiting for traffic to stop. They also failed to look at traffic, spent more time looking away from the road or were more frequently hit by oncoming vehicles, according to the studies reviewed.

When distracted by visually focused tasks (texting and looking down at mobile) in adult studies (Banducci et al., 2016; Basch et al., 2015; Licence et al., 2015; Lin & Huang, 2017; Pai, 2017; Schwebel, Davis, et al., 2012) or studies of children and adolescent pedestrians (Bungum et al., 2005; Pešić et al., 2016; Thompson et al., 2013)) pedestrians in real life or in virtual reality experiments tended to be hit by a vehicle, looked away from the street environment, crossed more slowly, took longer to cross, were least likely to look both ways before crossing and not start crossing the road at the marked pedestrian crossing.

Another important type of distraction studied was auditory distraction (listening to music and wearing headphones) for adults (Basch et al., 2015; Neider et al., 2011; Neider et al., 2010; Schwebel, Stavrinos, et al., 2012)) or both adults and children (Pešić et al., 2016; Thompson et al., 2013). In these studies, pedestrians tended to be hit by an oncoming vehicle, look away from the street environment, took longer to cross and crossed in the shortest time.

It has been identified from the study findings that mobile technology affects the life of adolescents in a number of ways. Mobile technology tasks may affect individuals in a variety of ways. The frequency of tasks and exposure opportunity is also associated with road safety. Cognitive Attention Theory has provided a conceptual framework of the impact of distraction on youth safety. The negotiating environments of streets requires people to have an ability to maintain a cognitive attention to various stimuli in a dynamic environment. Visual attention skills are essential and associated with the road safety prospects (Thompson et al., 2013). NHTSA.gov conducted a study to analyse the effect of distracted attention during walking. The authors defined distraction as including walking on a road, talking to anyone on a call, listening to music, or texting someone. The authors in this study observed pedestrians walking through a large central plaza. The findings of the study revealed that the use of mobile phones during crossing affected the concentration of people particularly as it related towards the traffic signals (Scopatz & Zhou, 2016)

Stavrinos et al. (2011) investigated the impact of different types of distractions on pedestrian injury risks such as spatial task through a phone, injury risk, including engaging in a mobile phone conversation and being involved in a mental arithmetic task verbally by phone. They found that there was a significant effect posed by the various distraction conditions in the study and the participants recruited in the study felt less safe under distraction conditions as opposed to undistracted conditions.

Further, the outcomes of pairwise comparisons showed that there were no differences between several distraction condition differences (Stavrinos et al., 2011). The study outcomes also highlighted that a naturalistic cell phone conversation resulted in riskier behaviour than arithmetic focused conversations (Stavrinos et al., 2011).

Stavrinos et al. (2009) examined the risky behaviour of adolescents regarding distraction due to telephone conversations. They recruited a total of 77 participants of age-group 11 in an interactive, immersive, virtual pedestrian surrounding. Before starting the experiment, respondents completed a group of familiarisation trials in a virtual environment. The respondents also completed behaviour measures of attention. In the experiment, each child was required to cross the virtual street six times by keeping themselves undistracted and then a further six times while being distracted by a mobile phone conversation. Stavrinos et al. (2009) calculated crossing scores, such as hits or close calls, safety time, start delay, and attention to traffic. The parents were also recruited in the study and they were asked to complete a questionnaire regarding their children's mobile phone use, and time devoted by their children to smart- phones per day (Chinn et al., 2004). The study results revealed a high probability that children behave in a risky manner while engaged in a mobile phone conversation.

2.4.6 Age differences

Most research was conducted on adults with the exception of six studies on children or adolescents (Bungum et al., 2005; Hatfield & Murphy, 2007; Pešić et al., 2016; Stavrinos et al., 2009; Tapiro et al., 2016; Thompson et al., 2013). All studies included males and females, but three studies did not record any information about gender (Basch et al., 2015; Tapiro et al., 2016; Violano et al., 2015)) see Table 2.4.

Although the age of participants included in this review ranged from children to young adults and older individuals, comparisons between the different age groups was given little attention. There was some indication that younger children and children who are less attentive and more oppositional may be slightly more susceptible to distraction while talking on a mobile phone (Stavrinos et al., 2009).

Most of the above research included the behaviour of adults. Tapiro et al. (2016) used a semi-immersive simulation of a virtual environment to conduct their research. As per the computer simulation used in this study, it was observed that almost 97% of adults crossed roads successfully without getting hit by vehicles.

In respect of the ‘safety gap’ measure, it was observed that the gap was longer for the youngest age group in comparison to adults. The adults were found to have crossed the road in a safer manner compared to children in the 7-8 year-old age group. The response time for adults was substantially shorter in comparison to the three groups for children aged 7-8, 9-10 and 11-13 years- old (adolescents), thereby indicating that they were quicker in crossing the road at the right time. However, no differences were determined between the response time among the three groups. There were no statistically significant differences between age-groups in regard to mobile phone distraction in any of the analyses. It was only adults who were found to be spending relatively less time in looking at the centre in comparison to others (Tapiro et al., 2016).

Thompson et al. (2013) found that with an increase in age, the crossing time per lane was also found to have increased. Pedestrians aged 65 years and above walked at a considerably slower rate per lane in comparison to the reference group of persons aged from 18 to 24 years old. (Thompson et al., 2013)

The findings of a study conducted by Neider et al. (2011) revealed that older adults between the ages of 59 to 81 years were less likely to be successful in crossing the roads in comparison with young adults aged between 18 to 26 years (Neider et al., 2011). Older adults were also found to be more likely to experience collisions in the more challenging trials. However, the probability of accidents was found to be low when they were conversing on the mobile phone or listening to music. It was also found that older adults showed a higher tendency of not being able to complete a trial within the given time in comparison to the younger adults (Neider et al., 2011).

Older adults also revealed a lesser tendency to be successful in completing a crossing in challenging traffic conditions such as when a red light turns to green, specifically in the duration of a conversation on a mobile phone (Neider et al., 2011). Neider et al. (2011) findings showed that more time was spent by the older adults while standing adjacent to the roads before initiating the crossing in comparison with the younger adults. The older adults were also found to be more affected by the challenges in crossing in comparison to younger adults. No precaution was adopted by the older adults to initiate the crossing when they conversed on the phone compared to the situations when they were undistracted (Neider et al., 2011).

2.4.7 Gender differences

In the context of the differences between genders, the findings of a study by Thompson et al. (2013) found that females tended to walk at a slower pace while walking in a group in comparison to their peers who walked alone. Thirty nine males did not wait for the signals to change and crossed the road, and 10 were using mobile phones. The findings revealed that waiting did not have any significant link to talking on a mobile phone for both males and females. In the context of males and females crossing the road, looking at traffic was considered only when there was traffic on the road. Additionally, it was found that seven females and all males in the study were careful in monitoring the traffic. It is noted that pedestrians did not walk while there was a green signal or there was a presence of traffic (Hatfield & Murphy, 2007). Only seven out of 39 males did not look at the traffic while crossing, but rather looked at the traffic signal to decide whether to walk or not. Three of these males were talking on the phone (Hatfield & Murphy, 2007). Only 14 out of 62 females and 8 out of 40 males looked at their phones for texting while crossing the road. Nevertheless, eight out of these females and five out of these males also looked at the traffic ahead. It was also found that all participants looked at the traffic while crossing and only if traffic was present, otherwise all were found to avoid doing so (Hatfield & Murphy, 2007).

Some studies in this review reported that males and females are affected differently. Among the studies that found gender differences were (Pai, 2017; Stavrinos et al., 2011). These studies found that female participants were more likely to perform all unsafe crossing behaviours compared to male participants. However, the difference was only marginal and non-significant statistically.

Table 4: **2.4 Characteristic of studies, major conclusions and research methodology**

Author	Country of the study	Sample size	Age in years, range, mean (gender)	Method Research design	Type of distractions	Major outcomes
Stavrinos et al., 2011	USA	108	17–41, 20.71 (F=63, M=45)	experiment an immersive, interactive virtual environment (real trial)	conversation	Mobile users are more distracted (looked left and right less) when engaged in cognitive activity (p=0.01)
Stavrinos et al., 2009	USA	77	10-11, 10.88 (F=37, M=40)	Experiment virtual environment (simulated road crossing)	conversation	More risky- behaviour by mobile and headphones while crossing when engaged in cognitive activity (P<0.05 overall).
Neider et al., 2011	USA	36	18 – 81, 22.0 (F=16, M=20)	Experiment virtual environment. a simulated street crossing task	Listening to music, or conversing	Older adults are more distracted than younger adults by both cognitive and auditory tasks (P<0.05).
Nasar., 2008	USA	187	university students	Experiment - real pedestrian environment pre-tested observation	Conversation	Non-users of mobiles - pedestrians noticed more objects in this cognitive task (P<0.05 overall).
Tapiro et al., 2016	Israel	52	7–29 M=12.0/25.4 (not recorded)	experiment semi-immersive virtual environment simulating a typical city	Conversation	Comparison of 3 different age groups suggested that older adults and children are more aware of the traffic than younger adults when using mobile phone (P<0.05 when older and children compared to young adults on crossing behaviour).
Neider, 2010	USA	36	18–30 M=21.75 (F= 19, M= 17)	experiment - an immersive virtual environment /a street-crossing task	listening to music, conversation	Comparison of 3 groups pedestrians were less likely to successfully cross the road when conversing on a cell. No significant differences (No conclusive significant differences between the groups.).

Schwebel et al., 2012	USA	138	17–45, 20.91(F= 88, M = 50)	Experiment - an interactive, semi-immersive virtual pedestrian street.	texting, listening to music, talking	Comparison of three distracted groups showed distraction from electronic devices has a small impact on college students' pedestrian safety (No conclusive significant differences between the groups).
Hatfield & Murphy, 2007	Australia	546	<10 -71 (F= 270, M=276)	Observation - observational methodology/ a case-control design	talking	Females and males, pedestrians who crossed while talking on a mobile phone crossed more slowly and were less likely to look at traffic before starting to cross, (Significant differences between the case and control group is affected by the gender of participants. (P<0.05 in most task).
Byington et al., 2013	USA	92	Mean=19.05 (F=74%, M=26%)	Experiment - virtual environment (VE) trials	Using the Internet	Distraction affected different road behaviours negatively (Significant effects between the groups/conditions. P<0.05 in all outcomes)
Thompson et al., 2013	USA	1500	<18-65+ (F=505, M=597)	Observation observational study	Talking, text, or listening to music	Distracted - pedestrians' behaviour was morerisky when engaged in cognitive, visual and auditory distraction activities. (All differences were significant.
Basch et al., 2015	USA	21,760	not recorded (not recorded)	Observation - observational study	Headphones, talking	Headphones use rates were higher during the 'Don't Walk' signal then during the 'Walk' signal. (Differences were significant)
Hyman et al., 2010	USA	317 + 151	college-age (F=253, M=215)	Observation observational study	Conversation.	Users of mobiles are more likely to engage in risky crossing behaviour (P<0.05).
Licence et al., 2015	UK	30	18-50 (F=18, M=22)	Experiment randomized, counter-balanced walking tasks over a course	texting	Participants took significantly longer to complete the course due to slower walking speeds under the cognitive distraction (P<0.05).

Bungum et al., 2005	USA	866	Teens-70 (F=276, M=439)	Observation observational study	Headphones, talking	Only 13.5% of walkers looked left and right and entered the crosswalk while the white light was flashing (Association between distraction and risky behaviour is weak.).
Banducci et al., 2016	USA	32	18–30, 22.28 (F=20, M=12)	Experiment - a simulated street-crossing task	Texting, conversations	During the phone conversation and texting conditions, participants had fewer successful crossings and took longer to initiate crossing (Not significant differences between conditions.).
Violano et al., 2015	USA	1362	adults (NOT RECORDE D)	Observation-observational study	Headphones, texting, talking looking at mobile phone or reading something	There were no differences in the proportion of pedestrians who were distracted at either intersection, except that more pedestrians were talking on a cell phone while crossing one intersection (No conclusive result).
PAI, C. 2017.	Taiw an	1669	mean=27.6 (F=714, M=990)	Observation-A controlled field study	Talking, texting, and listening to music	Mobile users are more likely to engage I a risky behaviour (<0.05 in all conditions examined).
Pešić et al., 2016	Serbi a	1194	⩽20,–>60 (F=202, M=196)	Observation - The method of scientific observation, cross-sectional studies	Listening to music, texting or viewing content on mobile phone, talking	Mobile users are more likely to engage in a risky behaviour (<0.05 in all conditions examined).
Lin et al., 2017	Taiw an,	24	young adults mean=23.5 (F=12, M=12)	Experiment virtual pedestrian walking environment	Talking or texting	Mobile users are more likely to engage in a risky behaviour (<0.05 in all conditions examined).

2.5 Summary

This systematic review was based on the hypothesis that the use of portable electronic devices such as mobile phones causes visual, cognitive and auditory distractions to pedestrians in a range of road related actions such as crossing the road at signposted and un-signposted places. Several studies compared the difference in scores between distracted and undistracted conditions while using the mobile phone (cognitive distraction), with fewer studies investigating texting or listening to music (visual or auditory distraction, respectively).

Overall, the studies suggested that while using mobile phones or headphones, pedestrians exhibited several risky road behaviours such as unsafe crossing behaviours, including taking longer to cross the road, walking slowly, looking down at the device and missing the chance to look sideways. However, almost half of the researchers investigated more than one type of distraction in the same study such as calling and texting or listening to music. (Violano et al., 2015; Bungume at al., 2005; Licence et al., 2015: Nasar.,2008; Neider et al., 2010; Neider et al., 2011; Stavrinos et al., 2011; Lin at al., 2017).

On the other hand, only four studies revealed no or a weak relationship between distracted outcomes and listening to music on headphones (Neider, 2010; Schwebel, 2012; Bungun, 2005; Violano, 2015). Additionally, no significant link was established between talking on phones and pedestrian behaviours in three studies (Banducci, 2016; Neider, 2010; Schwebel, 2012). However, this could be attributed to differences in sample sizes.

No studies mentioned increased safety when distracted. Some results found weak or even no statistically significant effects when comparing conditions in a variety of studies when distracted by using headphones or listening to music (Neider, 2010; Schwebel, 2012; Bungun, 2005; Violano, 2015). This study noted that no direct relationship was examined between talking on the phone while crossing roads and distracted behaviour in three studies (Neider 2010; Schwebel 2012; Banducci, 2016). A possible explanation for this may be that in the Neider (2010) study, the small sample size of 36 may have affected the results, in Schwebel's (2012) study, the experiment did not correspond with real life and in the Bungun (2005) study, the small sample was used for a wide age range from adolescents to 70 years old.

2.6 Limitations

Some of the limitations of this review were that there are few studies in the extant literature on adolescents using a mobile phone while crossing the road, and it is this aspect in particular that is important for organising education programs. One key limitation of this review is that the majority of the studies (14) were conducted in the same local culture: the USA. For this reason, it is difficult to extrapolate or generalise the findings to other countries. There is a need for future studies to include a wider range of cultural contexts, especially because both driving and pedestrian behaviour is intricately linked to cultural norms. Also, further studies should compare adolescent females and adolescent males in different conditions.

2.7 Conclusion

Pedestrians using mobiles phones are more likely to engage in unsafe road behaviour when using mobiles or headphones. However, this is based on observational studies and experimental studies with low sample sizes, suggesting the quality of evidence is low and more research is needed, particularly in a variety of differing cultural contexts. In this regard, the research being conducted aims to address this gap by undertaking research using a range of methods to examine this link from more than one aspect, and to determine how, and to what extent music devices and mobile phones lead to pedestrian injury among adolescents. In addition, the literature reviewed in this study did not explore mobile phone experience on the pedestrian decisions of adolescents and the link between risk taking and use of portable electronic devices in the context of pedestrian decision making. No studies compared factors influencing males and females. These omissions signify further gaps in the prevailing literature, which it is hoped this research can bridge so that the role of other surrounding factors such as demographic criteria and behavioural aspects among adolescents can be examined critically. The review of the literature selected suggests that most of the research in this area has been conducted on adults and not on adolescents, a strong indicator of a gap in the empirical literature. Therefore, this research will help in developing and making a useful contribution to the research in this area. To this end, it was decided to use observation of adolescents 'road-crossing behaviour in Chapter 3 and explore variables for further investigation. Further, the detailed analysis and presentation of findings about aspects such as distracting behaviour, road crossing behaviours, time of day, gender, pedestrian behaviour and electronic devices' effects, were all considered to meet the agenda and goals of this research.

Chapter 3. Observation of adolescent pedestrian behaviour

3.1 Introduction

The systematic review detailed in the previous chapter found that there is a paucity of research studies devoted to adolescents' road safety behaviour when using a mobile phone. The findings of the literature review highlighted that the use of headphones or mobile phones was strongly linked with unsafe behaviour among pedestrians. There were very few studies about the road-crossing behaviour of adolescents while using a mobile phone in everyday real traffic environments, such as outside schools. This study therefore sought to use an observation method for covering the gap in knowledge on the subject of the effects of electronic devices on adolescent''pedestrian behaviour by obtaining and presenting real-time and significant knowledge in this area. Moreover, this research also aimed to investigate how adolescents use mobile phones at the roadside, whether they were predominantly texting or answering phone calls, and tried to determine the way in which their road-crossing behaviour might be affected by this. The best way of gaining this information was through the observation method, which was found to be suitable because it provided a clear insight into adolescent pedestrian behaviour and the effects of mobile devices on it. The aim of this observational research, therefore, was to ascertain how adolescent pedestrian behaviour was affected by the use of portable electronic devices, such as a mobile phone.

Part of this observational study also involved recording gender while analysing pedestrian behaviour, as it was highlighted above (Chapter 1, section 1.1) that males have more road traffic accidents than females (Department for Transport, 2019). Steinberg's theory of adolescent risk-taking predicts more risky behaviour by adolescents when their peers and friends are present more than when alone. He explained that this is because taking risks with peers is more rewarding or exciting than taking risks alone. Therefore, in this study, adolescent pedestrians were observed when they were alone and when others were present.

Other aspects such as daytime, site and signals have also been taken into consideration to clearly observe and investigate adolescents' road-crossing or pedestrian behaviour while using mobile phones. Moreover, with the observation method, the types of distractions such as visual distractions (looking), auditory distractions (listening) and other activities-oriented distractions (texting) are also compared between adolescents with peers and adolescents alone as well as males and females among them.

In order to collect data for study (see appendix 3.1), road crossings have been observed to identify the pedestrian behaviour of school students and staff. The observation was conducted in two parts, with study 1 aiming to determine how many adolescents crossed the road with a phone or another electronic device. The second study was to conduct a more detailed observation of road-crossing behaviour in relation to different types of mobile phone use or another electronic device. In study 2, the data was obtained through observing other road crossings for investigating pedestrian behaviour of school students and other members in a UK setting.

3.2 Method

3.2.1 Study site

Permission was obtained to observe school students crossing a road near their school. The crossing site was a signalised ('pelican') crossing with traffic lights to stop vehicles and displayed a red or green person to indicate when the pedestrian should or should not cross (see Figure 3.1). The UK government Department for Transport's advice for crossing a road at a signalised pedestrian crossing is in the form of a series of rules. To the best of our knowledge, it is not illegal to cross on a red ("Do Not Walk") signal, but it is illegal to loiter on any form of crossing. Traffic travelled in two directions. The road had several lanes for mixed traffic. Two lanes were for general vehicle use, one lane was reserved for public transport, such as buses and taxis, and another lane was reserved for bicycles. The school was located in a large city in the north of England. The age range of students attending the school was that of UK high school students (i.e. between 11 and 18 years of age). The most recent UK Office for Standards in Education (Ofsted) report graded the school as outstanding. It also indicated that there was a higher than average number of students from 'financially deprived backgrounds'. The report described the school as a multicultural community. This is fairly typical of urban schools in the UK and in this respect the researcher considered the sample to be broadly representative of UK urban adolescents. Observations were carried out in the morning before school starting time and in the afternoon at school closing time over a four-week period in late spring to early summer in 2018. The majority of observations were made in dry weather conditions (sunny conditions = 42.8%, cloudy conditions = 39.6%, rain = 2.0%), and temperatures varied between 8.5°C and 27°C over this period.

Street view Pedestrian perspective

Figure 2: 3.1: Views of the road crossing site

3.2.2 Sample

Study 1

A total of 3442 road crossings by school students were observed for two days each week over a period of four weeks.

Study 2

A total of 795 road crossings by school students were observed for two days each week for four weeks in 2018. Study 2 data was collected on different occasions to study 1, so in this respect, it was independent of the data for study 1. For the purposes of comparison, the researcher attempted to more closely match the number of pedestrians with and without a phone in both studies. Consequently, 369 road crossings in study 2 were made with a phone or other electronic device visible and 426 were without a device visible.

3.2.3 Procedure

Ethical approval was obtained from the University of Lincoln Research and Ethics Committee, and the British Psychological Society's ethical guidelines were followed. Permission was obtained from the school to conduct the observation near school premises. Before commencing the observation, pilot studies were carried out by two observers for refining the coding categories and for calculating observer reliability analyses. The two observers agreed on 89% of road crossings. Subsequently, following further pilot studies, observations were carried out by a trained observer standing near the kerb edge facing the pedestrian.

For data collection, it was decided to focus on people including adults and peers to analyse the effects of electronic portable-type devices on pedestrian behaviour. The role of peers in risk-taking behaviour is relevant to Steinberg's theory. This theory postulates that in adolescents, the risk-taking attitude is reflected as an outcome of the comparison and competition between the distinct systems of the brain like cognitive-controlling system and the socio-emotional system that gradually mature during adolescence (Steinberg, 2014). Thus, in this study, the presence of other peers along with adults was taken into account for observation purposes because it was interesting to compare the risk taking of adults and other peers at the roadside based on their distinct cognitive systems.

For the first phase of data collection (study 1), the focus of the research was on how many adolescents crossed the road with a phone or another electronic device. Observations involved a basic frequency count of adolescent pedestrians crossing the road. Two categories were used: (1) pedestrians carrying an electronic device (mobile phone, headphones or earplugs) visible to the observer, and (2) no device visible to the observer. The observation for each pedestrian began when the pedestrian stepped off the pavement into the road and ended when they left the road and stepped back onto the pavement on the other side of the road.

As for study 2, the aim was to observe specific pedestrian behaviours when using a mobile phone or other device, and therefore, behaviours were observed as follows. Firstly, safe road-crossing behaviours that were observed were: (1) looking left and right before crossing (indicated by head movements), (2) crossing the road when the pelican device showed a green person, and; (3) crossing within the lines marked on the road for the cross-walk and taking the shortest route, but not diagonally. Secondly, technology use was categorised as: (1) mobile phone or other device visible to the observer, (2) no device, (3) holding device, (4) holding device to ear, (5) texting/swiping, and; (6) looking at device. Pedestrian characteristics were also noted, such as gender, and whether the pedestrian crossed alone or with others. Crossing with others was defined as crossing together, looking at or talking to each other. Additionally, a member of school staff stood outside the school near to the crossing point at school closing time for 15 minutes. Whether this adult was present, the time of day, and weather conditions were all factors also noted.

3.2.4 Data analysis

The data gathered was treated as observations of independent crossing events rather than observations of individual pedestrians. For study 1 data, frequencies and percentages were calculated to ascertain the amount of road crossings with or without a mobile device. For study 2 data, chi-square tests were used to analyse the link between technology use and road crossing behaviours. To avoid type 1 errors, Bonferroni corrections were applied to *p* values where multiple chi-square tests were calculated (Tables 3.1–3.3).

3.3 Results

Study 1: A total of 1080 pedestrian road crossings were made with an electronic device visible to the observer (31.37%) and 2362 without an electronic device (68.62%).

Study 2: Out of the total of 795 pedestrians observed crossing in study 2, 378 (47.55%) were male pedestrians and 417 (52.45%) were female pedestrians. 65.40% were observed in the morning between 8:00 and 8:45 am and 34.6% were observed between 3:05 and 3:40 pm. Approximately half of the road crossings were made by pedestrians who looked left and right before crossing (51.40%), 65.3% by pedestrians who crossed on the ‘green person’ and 57.6% by those who walked straight across the road within the road line markings for the cross-walk. Also, 369 (46.41%) road crossings observed in study 2 were made with a phone or other electronic device visible and 426 (53.58%) were made without a device visible. More females than males were observed with a device (female n = 242, 58.03% of female pedestrian road crossings; male n = 127, 33.59% of male pedestrian road crossings), holding a device (female n = 172, 41.25%; male n = 67, 17.72%), texting/swiping (female n = 37, 8.87%; male n = 20, 5.29%) and using headphones (female n = 138, 33.09%; male n = 84, 22.22%). More females than males failed to look left and right before crossing (female n = 217, 52.04%; male n = 169, 44.71%). Tables 3.1–3.5 presents the data from the study 2 observations.

3.3.1 Effects of electronic devices on pedestrian behaviour

As can be seen in Table 3.1 (below), road crossings made by pedestrians with a phone or another device more frequently involved failing to look left and right before crossing than those without a device. Furthermore, those holding a phone or engaging with the device by looking at the screen or texting/swiping were subsequently less likely to look left and right before crossing. However, other behaviours with a mobile phone such as speaking and/or listening (either by holding the phone to the ear or using headphones) did not affect looking left and right. Although it was noted that road crossings made by females were less likely to involve looking left and right before crossing, there were no statistically significant gender differences with regards to the link between mobile phone-use behaviour and looking behaviour.

Table 5: 3.1: Use of electronic devices in relation to road-crossing behaviours—looking before crossing (number of road crossings)

Phone/device use	Looked left and right before crossing	Did not look left and right before crossing	χ^2
Phone/others device visible	165	204	12.490*
No phone or other device	244	182	
Holding phone	92	147	22.953*
Not holding phone	317	239	
Speaking into phone	12	16	0.857
Not speaking into phone	397	370	
Looking at screen	26	48	8.691*
Not looking at screen	383	338	
Texting/swiping	19	38	8.065*
Not texting/ swiping	390	348	
Holding device to ear	7	19	6.471
Not holding device to ear	402	367	
Head/ear-phones	110	112	0.444
No head/ear-phones	299	274	

Table 6: 3.2: Use of electronic devices in relation to road-crossing behaviours—walk signal (number of road crossings)

Phone/device use	Crossed on green (walk signal)	Crossed on red (do not walk signal)	χ^2
Phone/other device visible	270	99	18.904*
No phone or other device	249	177	
Holding phone	179	60	13.932*
Not holding phone	340	216	
Speaking into phone	25	3	7.377*
Not speaking into phone	494	273	
Looking at screen	60	14	8.985*
Not looking at screen	459	262	
Texting/swiping	45	12	5.058
Not texting/ swiping	474	264	
Holding device to ear	21	5	2.844
Not holding device to ear	498	271	
Head/ear- phones	158	64	4.712
No head/ear- phones	361	212	

Table 3.2 shows that the majority of pedestrians crossed on a green (“Walk”) signal; however, for those who crossed on a red (“Do Not Walk”) signal, most did not have a mobile phone or other device with them, or were not holding, speaking or looking at the screen. All other correlations were non-significant. There was no statistically significant association between crossing within the road line markings for the cross- walk and phone/device use (Table 3.3).

Table 7: 3.3: Use of electronic devices in relation to road-crossing behaviours—cross- walk (number of road crossings)

Phone/device use	Cross within the cross- walk	Crossed outside the cross- walk	χ^2
Phone/other device visible	218	151	0.608
No phone or other device	240	186	
Holding phone	136	103	0.070
Not holding phone	322	234	
Speaking into phone	18	10	0.530
Not speaking into phone	440	327	
Looking at screen	46	28	0.692
Not looking at screen	412	309	
Texting/swiping	36	21	0.774
Not texting/ swiping	422	316	
Holding device to ear	14	12	0.156
Not holding device to ear	444	325	
Head/ear- phones	137	85	2.122
No head/ear- phones	321	252	

For Tables 3.1, 3.2 and 3.3, Bonferroni corrections were applied ($p = 0.05 / 7 = 0.007$) due to multiple phone-use comparisons (7) made for each type of road-crossing behaviour, and * indicates significance at $p = 0.007$.

3.3.2 Effects of other people and time of day on road-crossing behaviours

Compared to those crossing the road with peers, those crossing the road alone were more frequently observed looking left and right before crossing, crossing on a green signal and walking straight across the road within the road line markings for the cross- walk. However, only looking left and right was approaching significance (p = 0.053). Differences for crossing on green and crossing by the shortest route were statistically non-significant (see Table 3.4). The presence of an adult school staff member in the afternoons did not affect looking behaviour or crossing within the lines for the cross- walk, but significantly increased the frequency of crossings on a green (“Walk”) signal (see Table 3.4).

Table 8: 3.4: Effects of other people on road-crossing behaviours (number of road crossings)

	Looked left and right before crossing	Did not look left and right before crossing	χ^2	Crossed on green (walk signal)	Crossed on red (do not walk signal)	χ^2	Crossed within the cross-walk	Crossed outside the cross-walk	χ^2
Student alone	314	273	3.75	376	211	1.494	332	254	1.11
Student with peers	95	113		143	65		126	81	
School staff present**	63	77	0.444	110	30	4.167*	71	69	0.043
No school staff present**	39	57		64	32		50	46	

* p< 0.05, ** pm only

Pedestrians crossing the road in the morning more frequently looked in both directions before crossing than those crossing in the afternoon after school who looked less frequently ($p = 0.007$). Although the majority of road crossings were with pedestrians crossing on the green person signal, a higher proportion of road crossings were made during the red person signal in the morning (39.62% crossed on red, 60.38% on green) than in the afternoon (25.5% crossed on red, 74.5% on green) ($p < 0.001$). Also, although the majority walked within the road line markings for the cross- walk, a higher proportion did so in the afternoon (81.03% within the cross- walk, 19.07% outside) than in the morning (61.08% within, 38.02% outside). The morning period was divided into three time periods, according to whether it was comfortably before expected school arrival time (before 8:15 am), during peak arrival time (8:15–8:30 am), or when the school gates were about to be closed and the student would be late for school (after 8:30 am). We expected that pedestrians would take more risks when they were about to be late for school. There was a relatively higher frequency of failing to look left and right before crossing after 8:30 am, although this did not reach statistical significance. This did not occur at the earlier or peak arrival times (see Table 3.5). The majority of road crossings were made by pedestrians who crossed on green at all three time periods. Significantly more road crossings were outside the cross- walk lines than inside them after 8:30 a.m. This did not occur at the earlier arrival times.

Table 9 : **3.5: Safe behaviour associated with time of day (number of road crossings)**

Time of day	Looked left and right before crossing	Did not look left and right before crossing	χ^2	Crossed on green (walk signal)	Crossed on red (do not walk signal)	χ^2	Crossed within the cross-walk	Crossed outside the cross-walk	χ^2
Going to school (am)	286	234	7.599*	314	206	15.915*	317	203	6.914*
Return home (pm)	123	152		205	70		141	134	
Going to school before 8:15	38	37	2.943	47	28	3.233	57	18	9.225*
Going to school 8:15 to 8:30	224	164		227	161		224	164	
Going to school after 8:30	23	49		35	14		32	49	

* $p < 0.02$ *

3.4 Summary

Based on the overall findings obtained from the observation conducted in this chapter, it was found that almost a third of road crossings by school students on the route to and from school were made while using a mobile phone or music player. They were observed holding and interacting with these devices in a variety of ways while crossing, including speaking, texting or swiping, as well as listening. Regardless of whether a phone or device was in use, unsafe pedestrian behaviours were frequently observed. Mobile phones and other portable digital devices distracted adolescents 'looking behaviour at the roadside, especially when visual attention to the device was required.

In this study, 35.87% of pedestrians crossing on a ‘do not walk ’signal were observed with a phone or other device. Also, the majority of road crossings were on a green (“Walk") signal. However, most road crossings on a red ("Do Not Walk”) signal did not involve the pedestrian having or using a mobile phone.

Consequently, the study sought to explore gender differences in phone use and related pedestrian behaviours. The study results found that rates of electronic device use were proportionately higher for female than male pedestrians, with 58.03% of female pedestrians observed with electronic devices compared to 33.59% of males. However, the rates of unsafe pedestrian behaviour in relation to technology use were similar for males and females.

The effect of the presence of other people at the roadside depended on who the other person was. The presence of an adult school staff member did not affect looking behaviour or crossing within the road line markings for the cross- walk but did increase the frequency of crossings on a green (“Walk”) signal. The time of day was also observed an important determinant of safe pedestrian behaviour. Looking left and right was proportionately more frequent in the morning on the way to school and failing to look was more frequent in the afternoon on the way home from school. However, some after-school crossings were safer than morning crossings. For example, although the majority of pedestrians crossed on the green person signal, a higher proportion of road crossings were made during the red person signal in the morning than in the afternoon. Further, although the majority walked within the lines marked for the cross- walk, a higher proportion did so in the afternoon than in the morning. Another observation was also made in relation to the time of day effect in the mornings. Those who were late to school in the morning (after 8:30 am) crossed within the cross- walk lines significantly less frequently and looked left and right less often before crossing the road. This might be related to inattention to safety concerns while hurrying to get to school.

3.5 Limitations and future research

The limitations of the study included that observations were conducted at only one type of pedestrian crossing site at one school location. Additionally, the road had a slight curve, which may have affected pedestrian behaviour. Further research is needed on adolescent pedestrian behaviour and mobile phone distractions at other types of sites, particularly those with no traffic controls. More observations at different times of day would be beneficial, particularly in the afternoons when students are more likely to be exiting school. As the young pedestrians were not video recorded/filmed for ethical reasons, fewer observations were made in the afternoons because the majority of students left the school premises at the same time, making live observations more difficult. In contrast, arrival times were more staggered in the mornings. Also, observations were overt, and the researcher was clearly in view of the pedestrians, which could have affected their behaviour.

A further limitation resulting from the restrictions on filming young pedestrians is that it is possible that the same pedestrian was observed on more than one occasion. Consequently, our data should be interpreted as observations of crossing events rather than the behaviour of individual pedestrians. Although fairly detailed information was obtained about how the adolescent was using the phone or other electronic device, information about safe and unsafe pedestrian behaviour was limited to three categories of behaviour. Other behaviours that could be added to the observation would be waiting time and whether the pedestrian stopped at the kerb before crossing. As the school had a high proportion of students from low-income families, it is possible that our results represent a conservative estimate of adolescent pedestrian phone usage.

3.6 Conclusion

In conclusion, adolescent pedestrians are frequent users of mobile phones and music players when crossing the road and this affects their looking behaviour. While the findings obtained from this chapter provide a significant insight into the behavioural tendencies and practices undertaken by adolescents as pedestrians because of the use of mobile phones and electronic devices, it does not clarify the underlying causes for such behavioural practices adopted by adolescents. Based on the observations, it can be inferred that mobile phone usage raises safety issues among pedestrians while crossing roads which is also supported by Steinberg's theory related to risk taking attitudes, which supports the research aims. For this purpose, experiments were considered suitable to investigate some of the cognitive skills which might underlie their pedestrian behaviour, as was described in Chapter 1. The next chapter will examine the relationship between mobile phone distractions and adolescent pedestrian decision making and attention. The following chapter will present the results of experiments to analyse the relationship between self-regulation, risk-taking, mobile phone distraction and attention to pedestrian scenes, as well as whether self-regulation and risk-taking are related to adolescents' understanding of the dangers of using a mobile phone at the roadside.

Chapter 4. The role of electronic distractions and risk-taking in adolescents allocation of attention and awareness of pedestrian safety

4.1 Introduction

The observation study reported in Chapter 3 investigated several factors that affected adolescents' pedestrian behaviour, including mobile phones and headphones. Experimental methods, however, were considered more appropriate in investigating some of the skills and knowledge underlying adolescent pedestrian behaviour, such as their attention to pedestrian scenes and danger awareness. The experimental method is useful when exploring the role of age, gender, and experience of using mobile phones to analyse self-regulating, as well as the risk-taking behaviours of adolescents and their decisions while crossing roads.

The aims of the studies reported in this chapter are as follows:

1. To investigate age and gender differences in attention to pedestrian scenes.
2. To investigate age and gender differences in awareness of the dangers of using a mobile phone at the roadside.
3. To investigate the link between risk-taking, self-regulation, mobile phone experience and allocation of attention to pedestrian scenes.
4. To investigate the association between risk-taking, self-regulation, mobile phone experience and awareness of the dangers of using mobile phones at the roadside.

Hypotheses

Based on the aims of this study, the following hypotheses have been developed and will be examined:

1. There will be age and gender differences in mobile phone distraction.

2. There will be age and gender differences in risk behaviour.

3. There will be age and gender differences in attention to pedestrian scenes.

4. There will be age and gender differences in awareness of the dangers of using a mobile phone at the roadside.

5. There will be an association between risk-taking, self-regulation and allocation of attention to pedestrian scenes.

6. There will be association between risk-taking, self-regulation, and awareness of the dangers of using mobile phones at the roadside.

4.2 Method

4.2.1 Sample

A total of 50 high school students (25 females; 25 male) volunteered to participate in the experiment over a six-week period in 2019. Participants' ages ranged between 11 and 17 years, with an average age of 14 years. Participants were organised into two age groups: 11 – 13 years (n = 20) and 14 – 17 years (n = 30).

4.2.2 Materials

For the purposes of this study, the following materials were used:

1. Demographic Questionnaire
2. Attention to pedestrian Scenes (Change Blindness/Flicker Test)
3. Recognition of dangerous pedestrian mobile phone use
4. The Balloon Analogue Risk Task (BART)
5. Self- Regulation Questionnaire

Demographic questionnaire

This comprised of five questions linked to participants' age, gender, school, class and mobile phone experience (the number of years that a participant had owned mobile phone). See appendix 4.2.

Attention to Pedestrian Scenes (Change Blindness/ Flicker Test)

This task measured the ability of participants to detect changes in traffic scenes and was based on the flicker paradigm (Rensink et al., 1997; see appendix 4.3). It compared 16 pairs of colour photographs taken at various road-side locations in the UK. Each pair had an original and a copy of the image with one change that participants were asked to detect. Changes included the absence or presence of a part of a feature of the scene, and included two types of changes: (1) eight photographs with changes that could affect the safety of a pedestrian while making a road-crossing decision (pedestrian-relevant changes); see Photograph 1, and; (2) eight photographs with changes that were not relevant to the safety of a pedestrian (pedestrian-irrelevant changes); see Photograph 2.

These pedestrian-relevant changes included the presence or absence of a car, the presence or absence of a 'green person' (walk signal), and the presence or absence of a 'red person' (don't walk signal). Pedestrian-irrelevant changes included changes to a shop-window display, the presence or absence of a building and changes to street names.

Photographs were the stimuli and were displayed on a computer screen using bespoke software. Following a flicker paradigm (Resink, O'Regan & Clark, 1997), the original image in each pair alternated with the changed image but separated using a 170ms blank interval. This generated a repeating sequence of the original displayed for 500ms, followed by a blank grey field for 170ms, followed by the changed image for 500ms, followed by a grey screen for 170 ms, followed by the original again and so on. This cycle was repeated until, either, the change was detected and signaled by the participant pressing a computer key, or, no change was signaled within 10 periods of the stimulus cycle. Each stimulus pair was presented in a pseudo-random order after the three pairs of practice stimuli had been shown. All 16 stimulus pairs were presented to all participants in a repeated measures design (pedestrian-relevant and pedestrian-irrelevant changes). A score of 1 was given for a correctly- identified change, and 0 for no correctly- identified change. Response time was also measured in milliseconds. Three pairs of natural scenes were used as practice trials (e.g., a beach scene, a field).

The instructions included an explanation of what the participant would see on the screen and what they would be expected to do. The task was introduced to participants as a 'spot the difference' task, during which they would see a series of images on the computer screen in which something might change. The participant was told that, should they see a change, they should press the computer space bar as quickly as possible. Participants were also asked to say aloud what they thought had changed in order for the researcher to ascertain that the participant had identified the change correctly and was not guessing. The task began with three practice trials, which were not part of the data analysis. If participants failed to understand the tasks during the practice trials, the task was explained again and the practice trails repeated.

Figure 3: 4.1: Car changes - relevant to pedestrians

Figure 4: 4.2: Building changes - not relevant to pedestrian

Distraction

The distractions used were visual and auditory. A mobile phone was used to present a funny film to the participants. The aim of this task was to distract participants while the allocation of attention (change blindness) test was performed. Fifty per cent of participants were tested with the mobile phone distraction present and fifty per cent were tested without the distraction. Participants were allocated to either the phone distraction or no distraction condition randomly.

Recognition of dangerous pedestrian mobile phone use

Twelve colour photographs were used of a man standing at the roadside (see table 4.1). Four photographs were taken while the 'green person' signal was displayed on the light-controlled crossing (pelican crossing). Four photographs were taken while the 'red person' signal was displayed on the pelican crossing. Four photographs were taken where there was no light-controlled crossing (see appendix 4.4).

The man was pictured in four different positions:

(1) holding the phone at his side,

(2) holding the phone to his ear,

(3) looking at his phone, and;

(4) with no phone (see Photograph 3).

Participants' answers were recorded in a written document and scores were awarded as 1 point for a "danger" answer; for example responding, "no, it was not safe," and 0 for a "no danger" answer; for example responding, "yes, it was safe".

Participants were shown the photographs in a random order, and were asked, "Do you think it is safe for him to cross the road?" After giving their answer, participants were asked to explain the reason for their response. At the start of the task, the researcher asked participants whether they understood the task. If they said they did not understand, the task was explained to them again.

Figure 5: 4.3: Recognition of dangerous pedestrian mobile phone use

Table 10: 4.1: Photograph descriptions for recognition of dangerous pedestrian mobile phone use (red person light signal / no phone)

Site/Phone Use	Green Person Light Signal	Red Person Light Signal	No Light Signal
Holding Phone	√	√	√
Listening to Phone	√	√	√
Looking at Phone	√	√	√
No Phone	√	√	√

Photographs were displayed to participants randomly on computer screens. Participants' answers were recorded verbatim, and each answer was assigned a score of 1 if it demonstrated recognition of danger (e.g., "it is not safe"). The reasons participants gave were also categorised according to whether they included the mobile phone and type of phone use (e.g., holding, looking, listening or did not mention phone). Whether the road facilities (green man, red man, etc.) were mentioned was also noted.

The Balloon Analogue Risk Task (BART)

The Balloon Analogue Risk Test was used to measure risk-taking behaviour. Lejuez et al. (2002, p. 57-84) defined BART as, "a computerised measure of risk-taking behaviour." In the task, a balloon was displayed to participants. Each participant had an equal chance of earning money from pumping the balloon by pressing a button. Each inflation, instigated by pressing the button, was worth $.05. Pressing the button made the balloon size increase slowly, with each press generating the same amount of air. The money for each press was displayed on an on-screen counter until the balloon reached maximum size (resulting in winning the money) or exploded (resulting in losing the money). Each press therefore increased the chance of exploding the balloon while simultaneously increasing the chance of winning the money. If the participant chose to withdraw from the task before reaching the maximum size of the balloon, then they gained points based on the size reached. In total, this task used 30 balloons across a range of different contingencies. Participants were not informed of the balloon's potential to explode, which allowed for testing both the participants' initial responses to the task and changes in these responses as they gain experience. Accordingly, Lejuez et al. (2002) stated that, "risk taking is a related but phenomenological distinct process from impulsivity". The researcher adopted the methods of scoring of Bornovalova et al. (2005) and Lejuez et al. (2002), wherein BART performance was measured using on adjusted average number of pumps on unexploded balloons, with higher scores indicative of greater risk-taking propensity. Before the task was attempted, a practice trial was performed with participants to aid understanding of the activities to be performed.

Self-Regulation Questionnaire

The researcher used Moilanen's (2007) self-regulation questionnaire, which included four pages of 36 questions to record participants' ability to control their own behaviour in different ways, in particular on an emotional level.

In this test, the scale for short-term (13 items), and long-term (14 items) self-regulation factors was scored separately. In addition, a score of 1 was given for "not at all true for me" and 5 for "really true for me". The minimum possible score was 27 and the maximum possible score was 135, while the nine “lie” items were excluded from the score. Higher scores indicated a greater ability to self-regulate in the short- and long-term.

4.2.3 Design

Allocation of attention to pedestrian scenes

- An independent samples design was used to investigate the effects of mobile phone distractions on correct identification of changes and response time.
- Two independent groups were based on two conditions (with mobile phone distractions and without mobile phone distractions):
  (1) Sample with distraction conditions.
  (2) Sample with no distraction conditions.
- Dependent variables for this task were number of correct responses (correct identification of changes) and response time (time to press the computer key from the start of the display cycle).
- The independent variables were mobile phone distraction conditions (distraction/no distraction), pedestrian-relevance (relevant/not relevant), age (11-13 years/14-17 years) and gender. Distraction, age and gender were independent samples. Mobile ownership was organised into three groups: (A) 22 participants who had owned a phone for 1 – 2 years, (B) those who had owned a phone for 3-4 years and (C) those who had owned a phone for 5- 6 years.

- Pedestrian relevance was repeated measures. All 16 pairs of photographs were presented to all participants.
- A correlational design was used to investigate the relationship between risk-taking (as measured by the BART), self-regulation and chronological age.

The danger awareness task

For the recognition of mobile phone dangers task, a repeated measures design was used to compare responses to different types of phone use (holding, listening, looking and no phone).

Table 11: 4.2 Data analysis

Aim	Task	Analysis
Aim 1: to find out whether mobile phone distraction affects adolescents' attention to pedestrian scenes	Attention to pedestrian scenes (change blindness/ flicker test)	A mixed ANOVA to compare the number of correct responses (correctly identified changes) for two levels of distractions (between; distraction, no distraction) and two levels of pedestrian scenes (within; pedestrian-relevant, pedestrian-irrelevant). A mixed ANOVA to compare the response time for two levels of distractions (between; distraction, no distraction) and 2 levels of pedestrian scenes (within; pedestrian-relevant, pedestrian-irrelevant).
Aim 2: to investigate whether adolescents are aware of the risks of using a mobile phone when crossing a road	Recognition of mobile phone dangers	ANOVA was used to compare the number of 'danger' responses for four different conditions (within; holding phone, listening to phone, looking at phone, no phone).
Aim 3: to investigate whether some adolescents are affected more than others.	Attention to pedestrian scenes (change blindness/ flicker test).	A one-way ANOVA was used to compare age groups A t-test was used to compare males and females A one-way ANOVA was used to compare different time lengths of phone-ownership
	Recognition of mobile phone dangers task	Correlations were used to investigate relationships between risk-taking and attention to pedestrian scenes, as well as risk-taking and recognition of mobile phone dangers task.
	The Balloon Analogue Risk Task (BART)	Correlations were used to investigate relationships between self-regulation and attention to pedestrian scenes, as well as risk-taking and the recognition of mobile phone dangers task.
	Self-regulation	

4.2.4 Procedure

Permission to work with the adolescents involved in this project was obtained from their parents using a written consent form. Parents were informed in advance of the details of the materials used and the estimated time it would take for administering the test to each participant.

Parents and participants were provided with written information about the research, including consent and withdrawal information. The research was approved by the Human Research Ethics Committee of the University of Lincoln.

Before beginning the tasks, written consent was obtained from participants. The participants were then seated next to the researcher, with the laptop screen in front of them. Each participant completed the allotted number of questionnaires, beginning with the demographic questionnaire before completing the self-regulation questionnaire.

Once both questionnaires were completed, participants were asked to perform the change blindness/flicker test on the researcher's laptop. The task was introduced to participants as a 'spot the difference 'task, for which they would look at a series of images on the computer screen in which something might change. If participants noticed a change, they were asked to press the computer space bar as quickly as possible. Participants were then asked to say aloud what they thought had changed in order for the research to ascertain that the participants had identified the change correctly and were not guessing. The task began with three practice trails. For the actual task, 50% of the participants (the adolescents) completed the task with distraction conditions from the researcher's mobile phone (the showing of a funny film on a mobile phone screen). The participants in the no-distraction condition completed the test without any distraction conditions from the mobile phone.

The next task was the identification of the dangers of pedestrian mobile phone use; for these participants were asked to identify the level of risk at a particular crossing. This assessed whether participants could recognise a safe or unsafe road-crossing situation. The road-crossing situation task also used a laptop computer to show participants the visual stimuli (1-12 photographs displaying different road-crossing behaviours and positions) in a random order, which was determined by asking participants to choose pieces of paper with the stimulus numbers written on them.

Finally, the Balloon Analogue Risk Task (BART) was used to evaluate risk-taking behaviour. All tests were administered in one session and were completed in around 30-45 minutes, depending on the participant's speed and performance.

All participants were thanked for their cooperation when they finished the tasks. Data was collected from the period May 2019 to June 2019.

4.3 Results

4.3.1 The effect of mobile phone distraction on attention to changes referring to pedestrian scenes

The average scores for changes in correct identifications were similar for both the distraction condition and the no distraction condition (see Figure 4.4).

A two-way mixed ANOVA was used to compare:

(1) The number of correct answers with phone distraction and without phone distraction conditions (between samples).

(2) The number of correct answers in the pedestrian-relevant and pedestrian-not-relevant conditions (within samples).

The first result showed that there was no significant difference between distraction and no-distraction conditions for correct identification of changes, with $F(1, 48) = 0.337$, $p > 0.05$, partial eta squared = 0.007. There was a significant difference between scores for the pedestrian-relevant changes and the scores for pedestrian-not-relevant changes, $F(1, 48) = 145.874$, $p < 0.001$, partial eta squared = 0.752. Change detection was more accurate for changes relevant to pedestrians. The third result shows that there was no significant interaction between the effects of distraction and the effects of the type of changes (pedestrian-relevance), $F(1, 48) = 0.919$, $p > 0.05$, partial eta squared = 0.019.

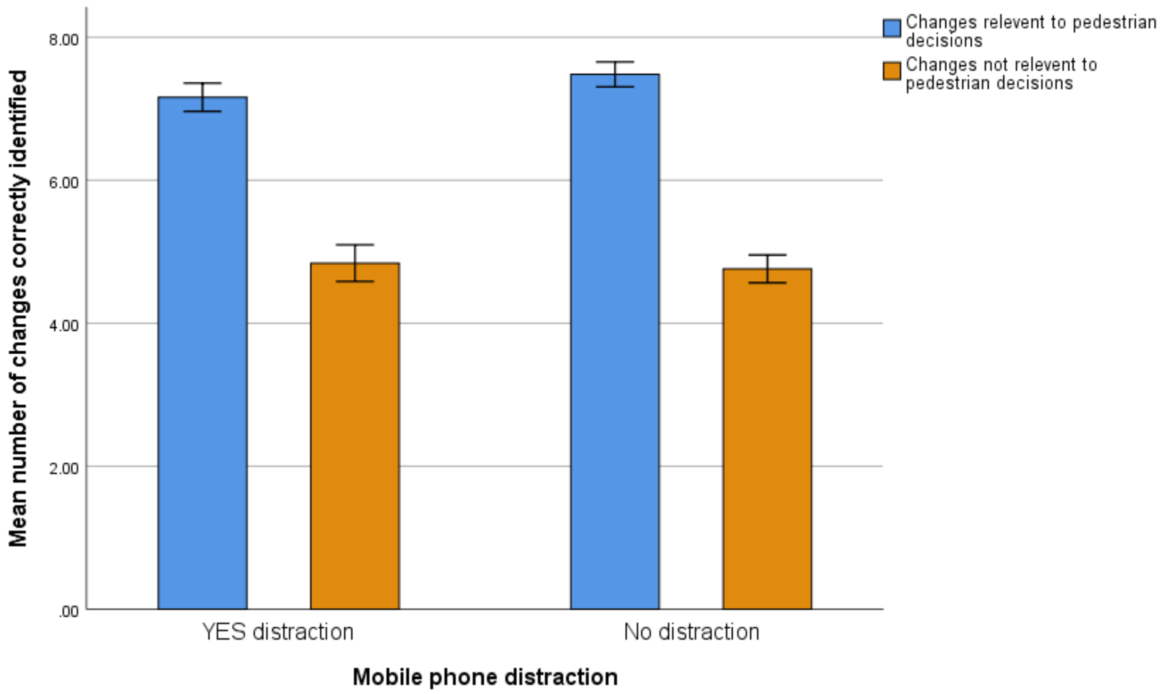


Figure 6: 4.4: Estimations for changes with regards to correct identifications in distraction and no distraction conditions

4.3.2 The effects of age, gender and mobile phone ownership on correct response change identifications

A one-way ANOVA and t-test was used to ascertain whether there were differences in correct change-detection between groups categorized by age, gender and time of mobile phone ownership.

Table 12: 4.3: Age-group differences for pedestrian-relevant and pedestrian-not-relevant changes (number of correct responses)

Age Groups	Pedestrian Relevant		Pedestrian Not Relevant	
	Mean	S. D	Mean	S. D
Age 11-13	7.20	1.06	5.05	1.32
Age 14-17	7.40	.86	4.63	. 96
All	7.32	.94	4.80	1.12
T	-.737		1.292	
p-value	.465		.203	

The t-test was used to determine whether there was a difference between age groups for the number of correct identifications for the pedestrian- relevant changes.

Table 4.3 shows no significant differences in means between age groups for the number of correct identifications to the pedestrian-relevant changes with $t(48) = 0.737$, $p > 0.05$.

Table 4.3 shows no significant differences in means between age groups for the number of correct identifications to the pedestrian-not-relevant changes with $t(48) = 1.292$, $p > 0.05$.

Table 13: 4.4 Descriptive statistics for distraction and no distraction between the two age groups of pedestrian-relevant and pedestrian-not-relevant changes (number of correct responses)

	Pedestrian Relevant		**Distraction**	Pedestrian Not Relevant	
Age 11-13	7.00	1.15		5.40	1.43
Age 14-17	7.27	.88		4.47	1.06
T	.654			1.877	
p-value	.520			.073	
	Pedestrian Relevant		**No Distraction**	Pedestrian Not Relevant	
Age 11-13	7.40	.97		4.70	1.16
Age 14-17	7.53	.83		4.80	.86
T	.368			.248	
p-value	.726			.807	

Table 4.4 shows that, for the distraction group, no significant difference was found between the age groups with $t(23) =.654$, $p>.05$. With regards to the no-distraction group, no significant difference in pedestrian-relevant changes between age groups was found with $t(23) =.368$, $p>.05$. Similarly, no significant difference was found in pedestrian-not-relevant changes with $t(23) = .248$, $p > 0.05$.

Table 14: **4.5: Mobile phone ownership group differences for pedestrian-relevant and pedestrian-not-relevant changes (number of correct responses)**

How long they have owned a mobile phone	**Pedestrian-relevant**		**Pedestrian-not-relevant**	
	Mean the number of correct responses	**S. D**	**Mean the number of correct responses**	**S. D**
between 1-2 years	7.182	1.053	4.773	1.343
between 3-4 years	7.500	0.707	4.778	1.003
between 5-6 years	7.300	1.059	4.900	0.876
All	7.320	0.935	4.800	1.125

Notes: significance at the *** – 0.01, ** and 0.05 level

Table 4.5 shows no significant differences in means between groups owning mobile phones for the number of correct responses to the pedestrian-relevant changes with F (2,47) = 0.565, p > 0.05, partial eta squared = 0.023.

Table 4.5 shows no significant differences in means between groups owning mobile phones for the number of correct responses to the pedestrian-not-relevant changes with F (2,47) = 0.048, p > 0.05, partial eta squared = 0.020.

Table 15: 4.6: Gender differences for pedestrian-relevant and pedestrian-not relevant changes (number of correct responses)

	Pedestrian relevant Response		Pedestrian Not relevant Response	
Gender	Mean	S. D	Mean	S. D
Female	7.28	0.94	4.96	1.17
Male	7.36	0.95	4.64	1.08
t-values	0.075		0.052	
P-Value	0.766		0.320	

Notes: *** – 0.01, ** and 0.05 level

Table 4.6 shows that the t-test=0.075 with $p > 0.05$ for pedestrian-relevant responses and t-test=0.052 with p-value=0.320 for pedestrian-not-relevant responses, indicating that there were no significant differences between males and females.

4.3.3 Correlation between variables

Table 4.7 presents the Pearson correlation coefficients for the association between pedestrian-relevant changes (correct responses) and the Balloon Analogue Risk Task (BART), short-term self-regulation, long-term self-regulation, and chronological age. There were no significant correlations between variables.

Table 16: 4.7: Pearson Correlation between Pedestrian relevant changes (number of correct responses) with different variables

	Pedestrian relevant change	The Balloon Analogue Risk Task (BART)	Short-term Self-regulation	Long-term Self-regulation	Chronolog-ical age
Pedestrian relevant change	-	0.11	-0.19	0.07	0.09
The Balloon Analogue Risk Task (BART)	0.11	-	-0.22	0.20	0.10
Short-term Self-regulation	-0.19	-0.22	-	0.14	0.05
Long-term Self-regulation	0.07	0.20	0.14	-	-0.05
chronological age	0.09	0.10	0.05	-0.05	-

Notes: significance at the *** – 0.01, ** and 0.05 level

Table 4.8 presents the Pearson correlation coefficients for the association between pedestrian-not-relevant changes (correct responses) and the Balloon Analogue Risk Task (BART), short-term self-regulation, long-term self-regulation, and chronological age. There were no significant correlations between variables.

Table 17: 4.8: Pearson correlation between pedestrian-not-relevant changes (correct responses) with different variables

	The Balloon Analogue Risk Task (BART)	short-term self-regulation	long-term self-regulation	chronological age	Pedestrian Not relevant changes
The Balloon Analogue Risk Task (BART)	-	-0.22	0.20	0.10	-0.01
short-term self-regulation	-0.22	-	0.14	0.05	0.05
long-term self-regulation	0.20	0.14	-	-0.05	0.07
chronological age	0.10	0.05	-0.05	-	-0.04
Pedestrian Not relevant changes	-0.01	0.05	0.07	-0.04	-

Notes: significance at the *** – 0.01, ** and 0.05 level

4.3.4 The effects of age, gender and mobile phone ownership on response time (in Milliseconds) change identifications

The results show that there was no significant effect of phone distraction on response time for the changes with $F(1, 48) = 0.338$, $p > 0.05$, partial eta squared = 0.956. A significant effect was found for pedestrian-relevant changes with $F(1, 48) = 236.573$, $p < 0.001$, partial eta squared = 0.831. Faster response identification of changes was more apparent for those relevant to pedestrians than for those that were not relevant to pedestrians. In addition, no significant interaction was found between distraction condition and pedestrian- relevance $F(1, 48) = 2.851$, $p > 0.05$, partial eta squared = 0.056.

Table 18: 4.9 Response time to changes and mobile phone distraction

	Mobile phone distraction	Mean	SD
Response time for relevant changes	YES	4200.96	2528.15
	No	3333.43	1117.13
	Total	3767.19	1983.38
Response time for not relevant changes	YES	9305.69	1853.16
	No	9697.18	2060.44
	Total	9501.43	1949.50
YES distraction		6753.32	
No distraction		6515.30	
ANOVA between Mobile phone distraction $F(1, 48) = 0.338$, $p > 0.05$, partial eta squared = 0.956			
ANOVA Between mean the response time of the changes $F(1, 48) = 236.573$, $p < 0.001$, partial eta squared = 0.831			
Interaction between phone distraction and the response time of the changes $F(1, 48) = 2.851$, $p > 0.05$, partial eta squared = 0.056			

Table 19: 4.10 Age-group differences for pedestrian-relevant and pedestrian-not-relevant changes of response time in milliseconds

Age groups	Pedestrian Relevant		Pedestrian Not Relevant	
	Mean	S. D	Mean	S. D
Age 11-13	27936.5	8046.41	77731.80	15041.47
Age 14-17	31604.8	19426.90	74864.57	16104.38
All	30137.52	15867.02	76011.46	15595.98
T	.798		.633	
p-value	.429		.530	

Table 4.10 shows no significant differences in means between pedestrian-relevant changes and response time between age groups with t(48) = 798, $p > 0.05$.

Table 20: 4.11: Age differences (distraction and no-distraction groups) for pedestrian-relevant and pedestrian-not-relevant changes in response time in milliseconds

	Distraction			
	Pedestrian-relevant		Pedestrian-not-relevant	
Age 11-13	3578.98	1301.00	8928.79	1697.90
Age 14-17	4615.6	3067.29	9556.96	1965.91
T	1.005		.825	
p-value	.326		.418	
	No distraction			
	Pedestrian-relevant		Pedestrian-not-relevant	
Age 11-13	3405.15	652.90	10504.16	1789.22
Age 14-17	3285.6	1363.53	9159.18	2108.22
T	.257		1.656	
p-value	0.799		0.111	

The data in table 4.11 was divided into two groups: distraction and no distraction. When the same comparisons were repeated for the distraction group, there was no significant difference in relevant change between age groups with $t(23) = 1.005$, $p>.05$. Similarly, no significant difference was found in not-relevant changes with $t(23) = .825$, $p > 0.05$. As for the no-distraction group, there had been no significant difference in response time between age groups, $t(23) = .257$, $p>.05$. In respect of the no-distraction group, for pedestrian- relevant changes, there were no significant differences in response time between age groups, $t(23) = .257$, $p>.05$. There was also no significant result for pedestrian-not-relevant changes, $t(23) = 1.656$, $p>.05$.

Table 21: 4.12: Owned a mobile phone differences for pedestrian-relevant and pedestrian-not-relevant changes to response time in milliseconds

Owned a Mobile phone Groups	Pedestrian-relevant		Pedestrian-not-relevant	
	Mean	S. D	Mean	S. D
between 1-2	3442.13	1203.82	10323.74	1830.69
between 3-4	3430.22	1265.88	8569.84	1868.51
between 5-6	5088.88	3547.20	9369.23	1693.84
All	3767.19	1983.38	9501.43	1949.50
	F (2,47) = 3.002, p=0.059		F (2,47) = 4.634, p = 0.015*	

Table 4.12 shows owned a mobile phones differences for pedestrian-relevant changes of response time in milliseconds between age groups, using ANOVA. The results showed that there were no significant differences $F(2,47) = 3.002$, $p > 0.05$. In contrast, there were significant differences in means values for pedestrian-not-relevant changes to response time $F(2,47) = 4.634$, $p < 0.05$, partial eta squared = 0.165. This group (i.e. the between 1-2 group) responded faster to the pedestrian-not-relevant changes, suggesting that mobile phone distraction affects response time.

Table 22: 4.13: Gender differences for pedestrian-relevant and pedestrian-not relevant changes to response time in milliseconds

	Pedestrian relevant		Pedestrian Not relevant	
Gender	Mean	S. D	Mean	S. D
Female	3624.17	1465.48	9822.55	2007.43
Male	3910.21	2416.86	9180.32	1874.79
Sig. (2-tailed) P- value	t=1.16, p=0.615		t=-0.506, p=0.248	

Table 4.13 determines that gender did not significantly affect response time for both pedestrian-relevant, t=1.16, p>0.05 and pedestrian- not relevant changes, t=-0.506, p >0.05.

Table 23: **4.14: Pearson correlation between pedestrian-relevant changes to response time in milliseconds with different variables**

	The Balloon Analogue Risk Task (BART)	**Short-term self-regulation**	**Long-term self-regulation**	**Chronological age**	**Mean response time for relevant changes**
The Balloon Analogue Risk Task (BART)	-	-0.22	0.20	0.10	0.27
Short-term self-regulation	-0.22	-	0.14	0.05	-0.10
Long-term self-regulation	0.20	0.14	-	-0.05	-0.21
Chronological age	0.10	0.05	-0.05	-	.294
Mean response time for relevant changes	0.27	-0.10	-0.21	.294	-

Table 4.14 presents the Pearson correlation coefficients for the association between pedestrian-relevant changes (response times) and the Balloon Analogue Risk Task (BART), short-term self-regulation, long-term self-regulation, and chronological age. There were no significant correlations between variables.

Table 24: 4.15: Pearson correlation between pedestrian-not-relevant changes (response times) and different variables

	The Balloon Analogue Risk Task (BART)	short-term self-regulation	long-term self-regulation	Chronological age	Mean response time for Not relevant changes
The Balloon Analogue Risk Task (BART)	-	-0.22	0.20	0.10	0.18
short-term self-regulation	-0.22	-	0.14	0.05	0.17
long-term self-regulation	0.20	0.14	-	-0.05	-0.16
chronological age	0.10	0.05	-0.05	-	0.02
Mean response time for Not relevant changes	0.18	0.17	-0.16	0.02	-

Table 4.15 presents the Pearson correlation coefficients for the association between pedestrian-not-relevant changes (response times) and the Balloon Analogue Risk Task (BART), short-term self-regulation, long-term self-regulation, and chronological age. There were no significant correlations between variables.

4.3.5 Risk- taking compared by age

BART mean scores were 20.71 (SD = 11.23) for 11-13year olds and 21.14 (SD =11.03) for 14-17year olds. Comparisons using a t-test found there was no significant difference; $t(48) = -0.13$, $p = 0.893$.

Part 2

Recognition of danger in photographs of a person crossing the road with and without a phone

In this section, the study examined whether adolescent participants were aware of the dangers of using mobile phones when road-crossing. This tested:

(1) The type of phone use could affect recognition of danger (i.e. the number of “no, it is not safe” responses). The type of phone was portrayed in the photographs at four levels: no phone; looking; listening; holding.

(2) Age and gender differences in danger recognition scores (i.e. the number of “no, it is not safe" responses).

4.3.6 Comparing type of mobile phone use between age groups

There was a difference in the mean number of “not safe" responses between the four types of phone use portrayed in the photographs. Figure 4.5 indicates that, for both age groups of adolescents, listening and looking were perceived to be the most dangerous activities, while holding and no having mobile phone was seen to be the least dangerous. The different types of phone use (no phone, hearing, looking, holding) produced results of F (3, 48.) = 21.155, $p < 0.01$, partial eta squared = 0.971. Hearing and looking had the most "not safe" responses, while no phone use had the fewest "not safe" responses. There was no significant difference between age groups (11-13 years and 14-17 years); F (1, 48) = 1.42, p> 0.05. There was no significant interaction between age and type of mobile phone use shown in the photographs; F (1.48) = 1.19, p> 0.05.

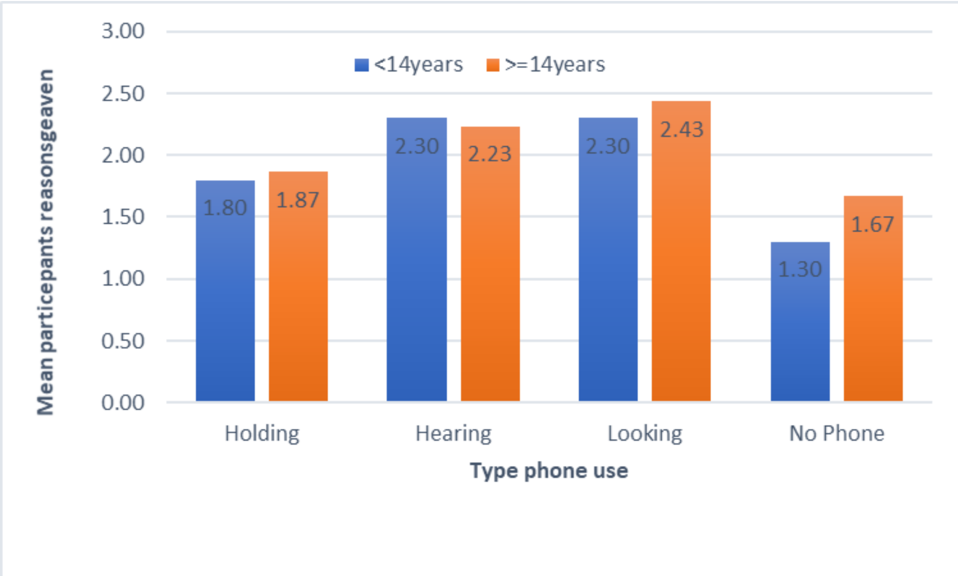


Figure 7: 4.5 Comparing type of phone use between age groups

4.3.7 Comparing type of mobile phone use between gender

There was a difference in the mean number of "not safe" responses between the four types of phone use portrayed in the photographs. Figure 4.6 reveals that there is a significant difference between the different types of phone use (no phone, listening looking, holding); F (3, 48.) = 20.452, $p < 0.05$, partial eta squared = 0.971. Listening and looking received the most "not safe" responses, while no phone had the fewest “not safe” responses. Adolescents reported that listening and looking were the most dangerous types of use, with holding and no phone the least dangerous. There was no significant difference between gender groups; F (1, 48) = 1.42, $p > 0.05$, partial eta squared = 0.067. Additionally, there was no significant interaction between gender and type of mobile phone use shown in the photographs; F (1, 48) = 0.59, $p > 0.05$, partial eta squared = 0.171.

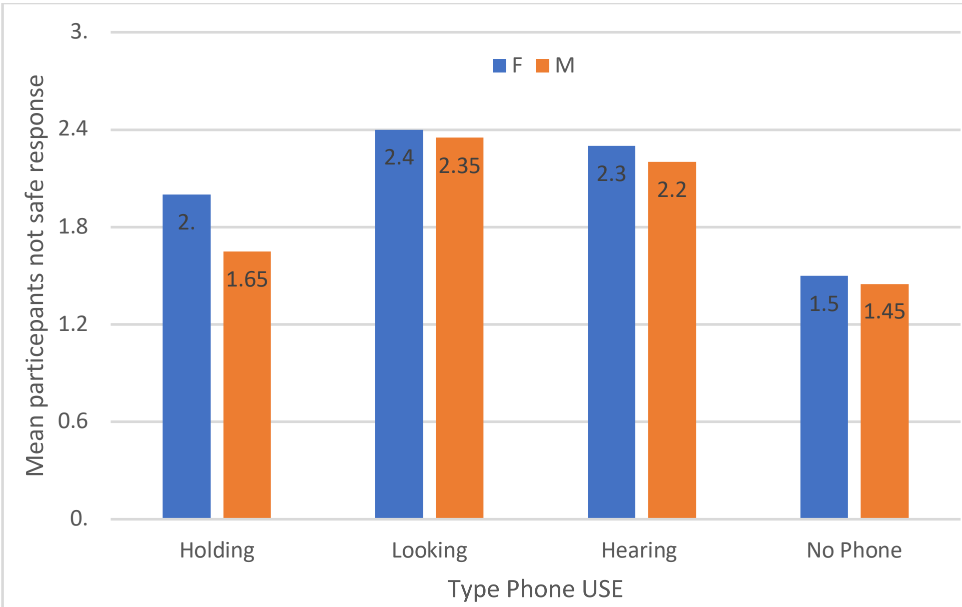


Figure 8: 4.6 Comparing type of phone use between gender

4.3.8 Correlation between total "Not Safe" response

Table 25: 4.16 Pearson Correlation between total "not safe" response 'danger' scores

	Total 'danger' scores	Chronological age	When owned first mobile	Long-term self-regulation	Short-term self-regulation	The Balloon Analogue Risk Task (BART)
Total 'danger' scores	-	0.11	-0.04	0.10	0.09	0.14
Chronological age	0.11	-	.623**	-0.05	0.05	0.10
When owned first mobile	-0.04	.623**	-	-0.06	0.05	0.08
Long-term self-regulation	0.10	-0.05	-0.06	-	0.14	0.20
Short-term self-regulation	0.09	0.05	0.05	0.14	-	-0.22
The Balloon Analogue Risk Task (BART)	0.14	0.10	0.08	0.20	-0.22	-

Notes: Asterisks denote significance at the *** – 0.01 and ** – 0.05

Table 4.16 shows that there was no significant correlation between the variables (total danger score, BART, short-term self-regulation, long-term self-regulation, exact age and years owned a mobile phone) ; the only correlation was between when the first mobile phone was owned and exact age, which was significant at 0.623, p= 0.05.

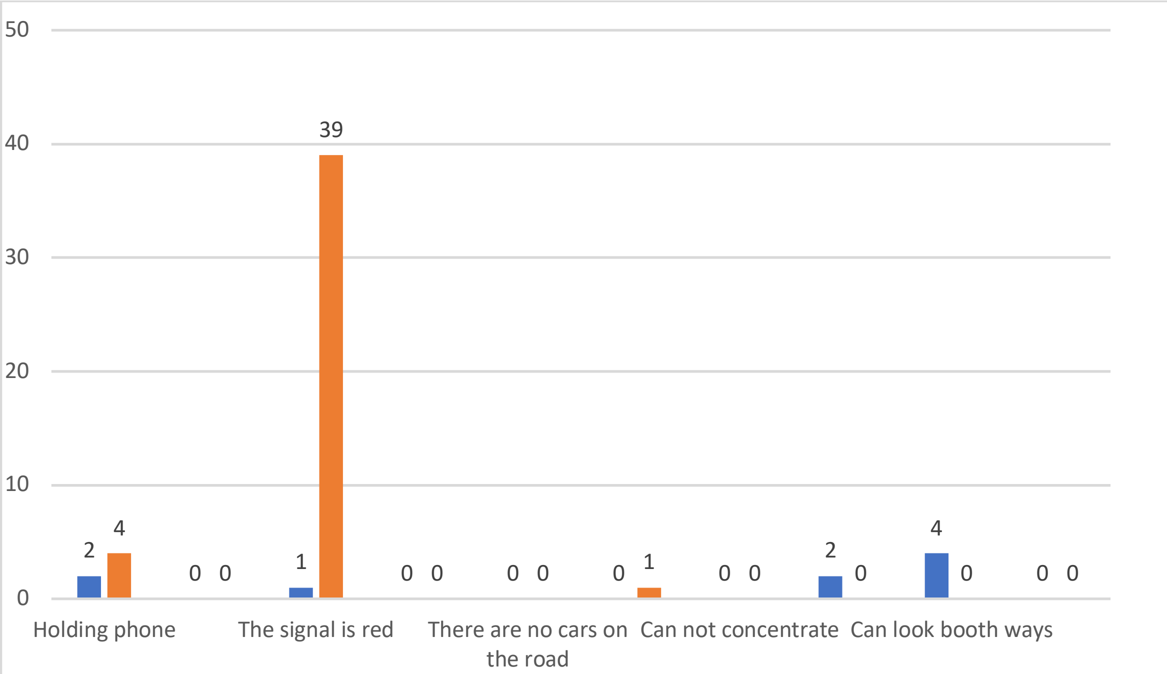
4.3.9 Reasons for reporting that it was not safe to cross

Descriptive statistics were used to determine the reasons participants gave for their answers, as well as for ascertaining whether participants considered the mobile phone as a reason for it being unsafe to cross.

The results show that 39 adolescents who said it was not safe to cross when holding a mobile phone at the “red person” signal gave the red signal as their reasoning. Four of the adolescents who said it was safe to cross when holding a mobile phone at the “red person” signal also gave that the red man signal as their reasoning (See Figure 4.7).

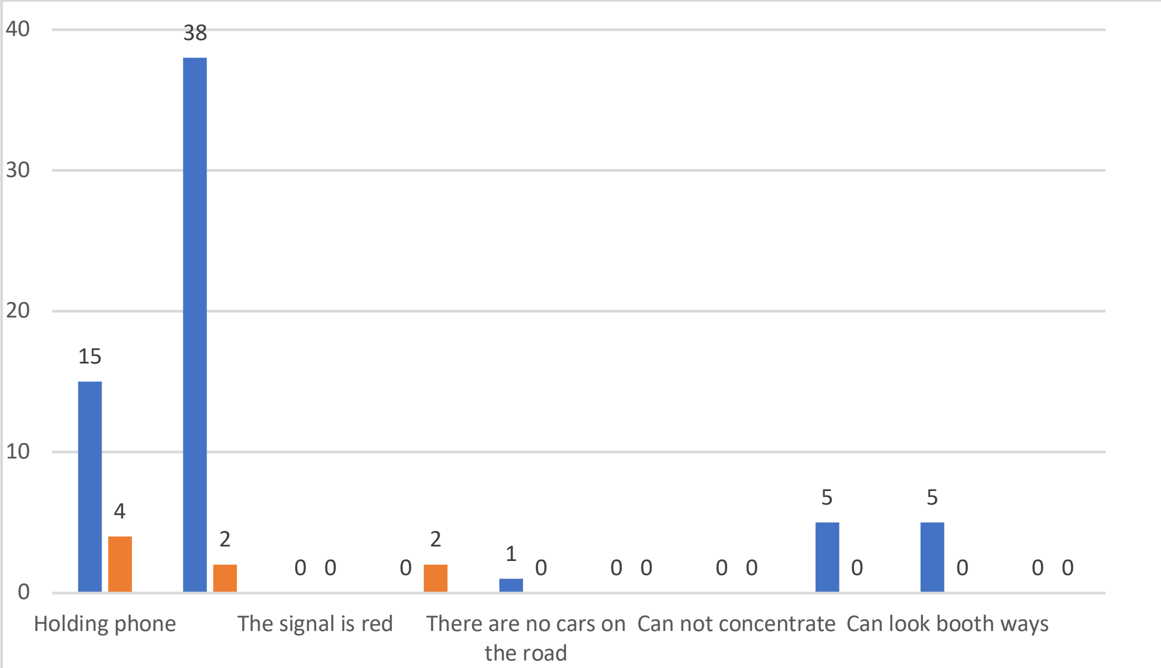
The results show that, of the adolescents aware of the risks of holding a mobile phone when crossing a road, 38 stated that it was safe to cross when holding a mobile phone at the “green person” signal and gave the green signal as their reasoning. Likewise, 15 of the participants who stated that it was safe to cross when holding a mobile phone at the “green person” signal gave holding a mobile phone as their reasoning. Finally, five of the adolescents who stated that it was safe to cross when holding a mobile phone at the “green person” signal gave an ability to concentrate and look both ways as their reasoning (see Graph 4.8).

Figure 4.9 shows that 31 of the participants who were aware of the risks of holding a mobile phone when crossing the road stated that it was not safe to cross when holding a mobile phone with no crossing signal and gave the absence of any crossing signal as their reasoning. Furthermore, 22 participants who stated that it was not safe to cross when holding a mobile phone at a crossing without any present signals gave the absence of a signalled crossing as their reasoning.



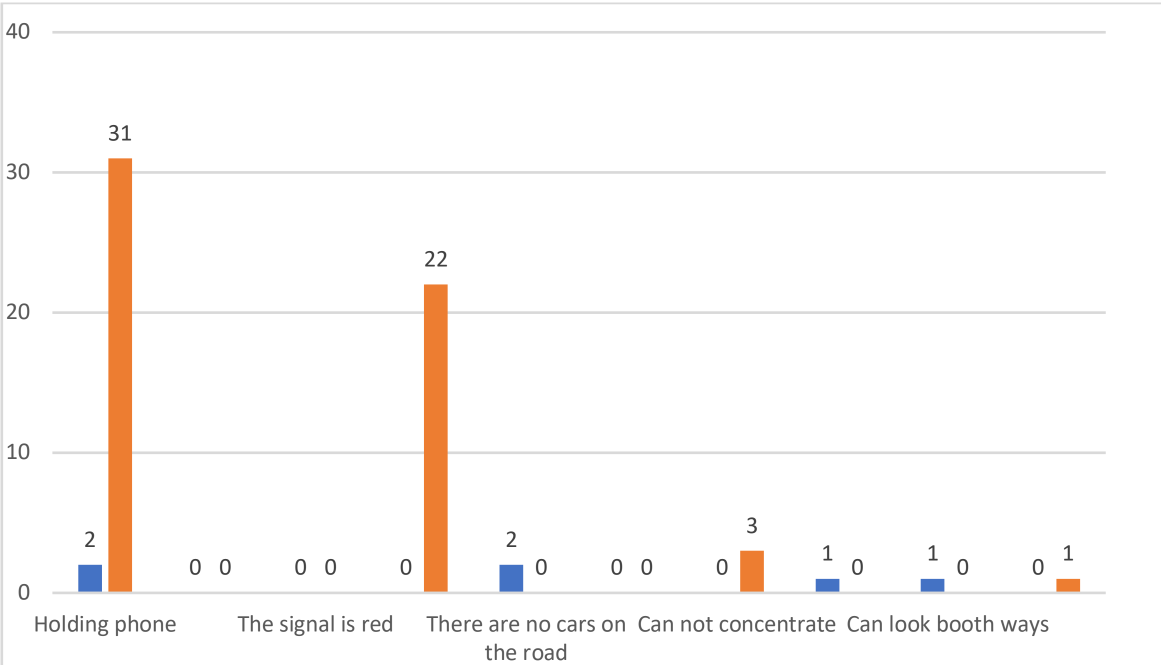
yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 9: 4.7 Holding a mobile phone with a "Red Person" Signal Light



yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 10: 4.8 Holding a Mobile Phone with a "Green Person" Signal Light



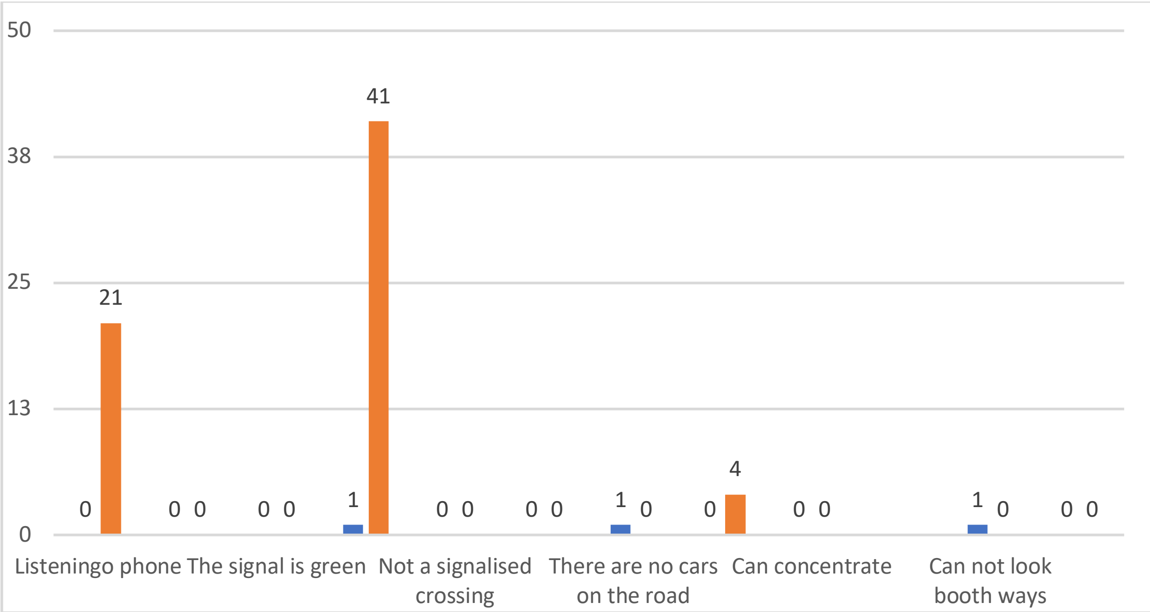
yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 11: 4.9: Holding a Mobile Phone with No Signal Light

The results in Figure 4.10 reveal that 41 of the participants who were aware of the risks of listening to a mobile phone when crossing the road stated that it was not safe to cross when listening to a mobile phone at the “red person” signal, and gave the red signal as the reason why. In addition, 21 participants stated that it was not safe to cross the road when listening to a mobile phone at the “red person” signal and gave listening to the mobile phone as the reason why.

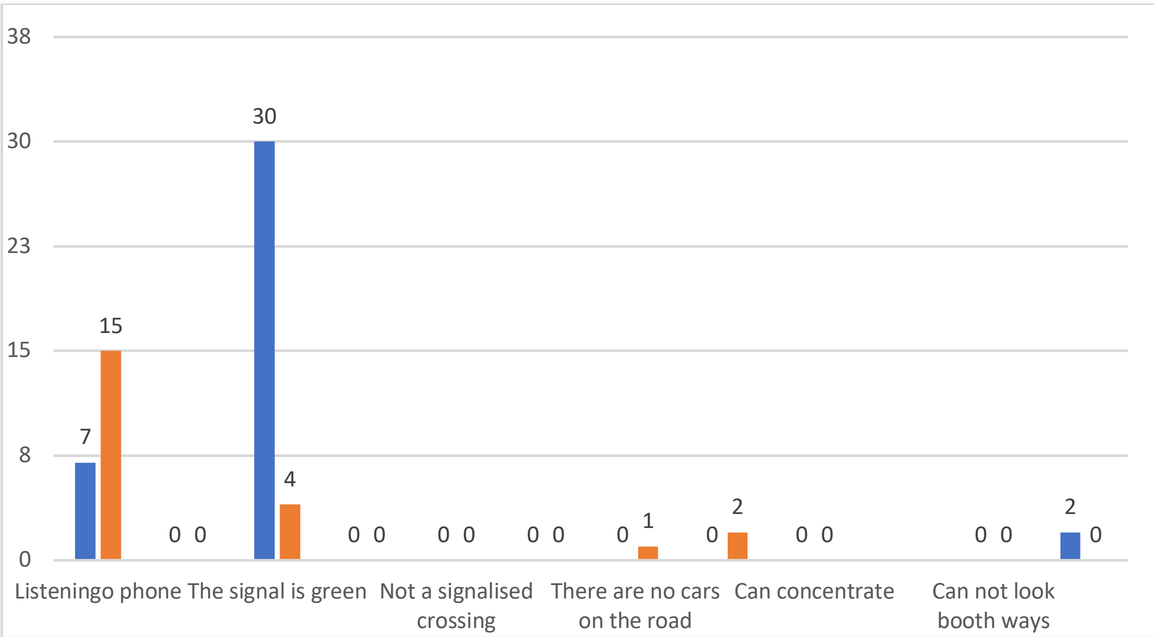
The results shown in Figure 4.11 reveal that 30 of the participants who were aware of the risks of listening to a mobile phone when crossing a road, deemed that it was safe to cross when listening to a mobile phone at the “green person” signal, and gave the presence of the green signal as the reason why. In addition, 15 of the participants stated that it was not safe to cross when listening to a mobile phone at the “green person” signal and gave listening to a mobile phone as the reason why. Seven participants stated that it was safe to cross when listening to a mobile phone at the green signal, and have that listening to the mobile phone was the reason why. Finally, four participants stated that it was not safe to cross when listening to a mobile phone at the “green person” signal, and gave the presence of the green signal as the reason for their answer.

The results in Figure 4.12 show that the 39 participants who were aware of the risks of listening to a mobile phone when crossing the road stated that it was not safe to cross when listening to a mobile phone with no signal light, and gave listening to the mobile phone as the reason for their answer. 20 participants stated that it was not safe to cross the road when listening to a mobile phone with no signal light and gave the absence of a signal as the reason for their answer. Finally, five adolescents stated that it was not safe to cross when listening to a mobile phone with no signal light and gave the inability to concentrate as the reason for their answer.



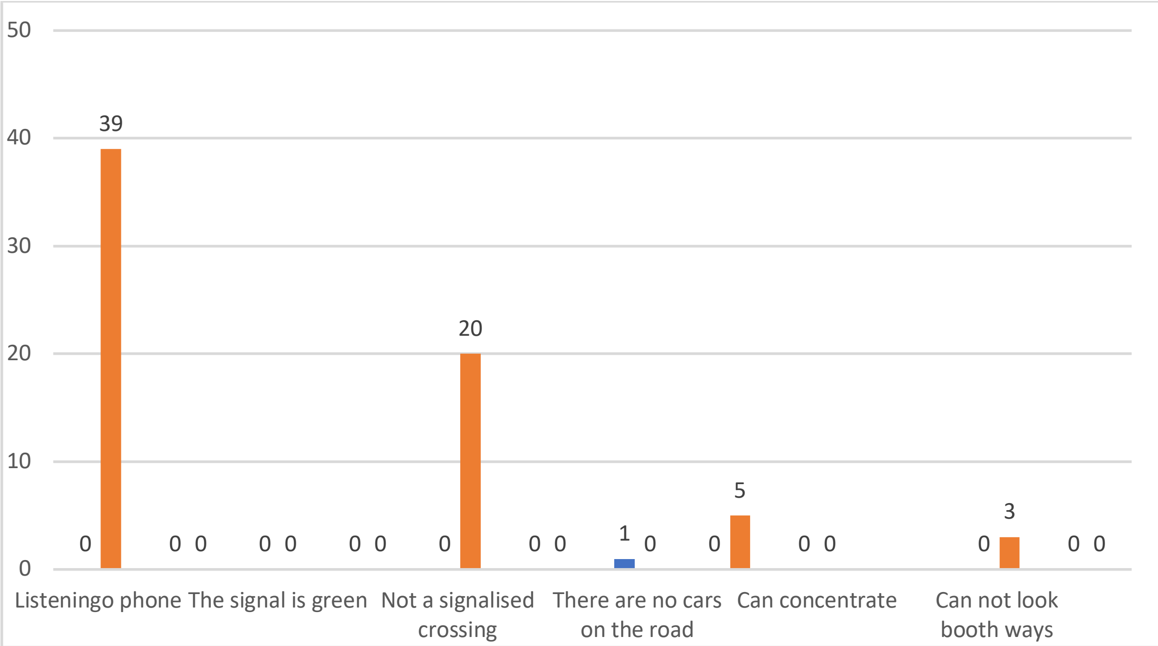
yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 12: 4.10: Listening to a mobile phone with a "red person" signal light



yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 13: 4.11: Listening to a Mobile Phone with a "Green Person" Signal Light



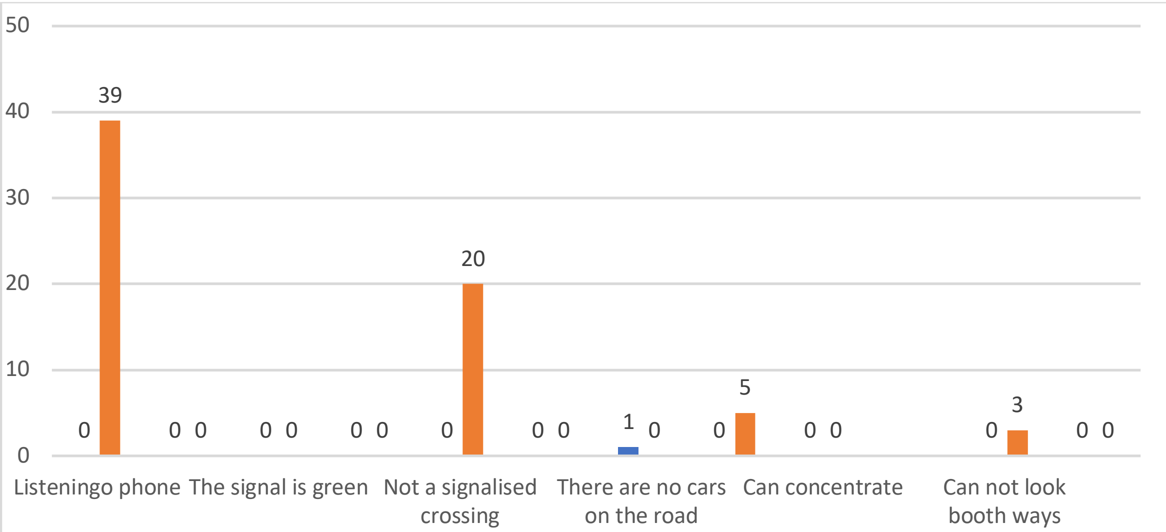
yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 14: 4.12: Listening to a mobile phone with no signal light

The results show that 43 participants deemed it unsafe to cross the road when looking at a mobile phone at the "red person" signal and gave the red signal as the reason for their answer (See Figure 4.13).

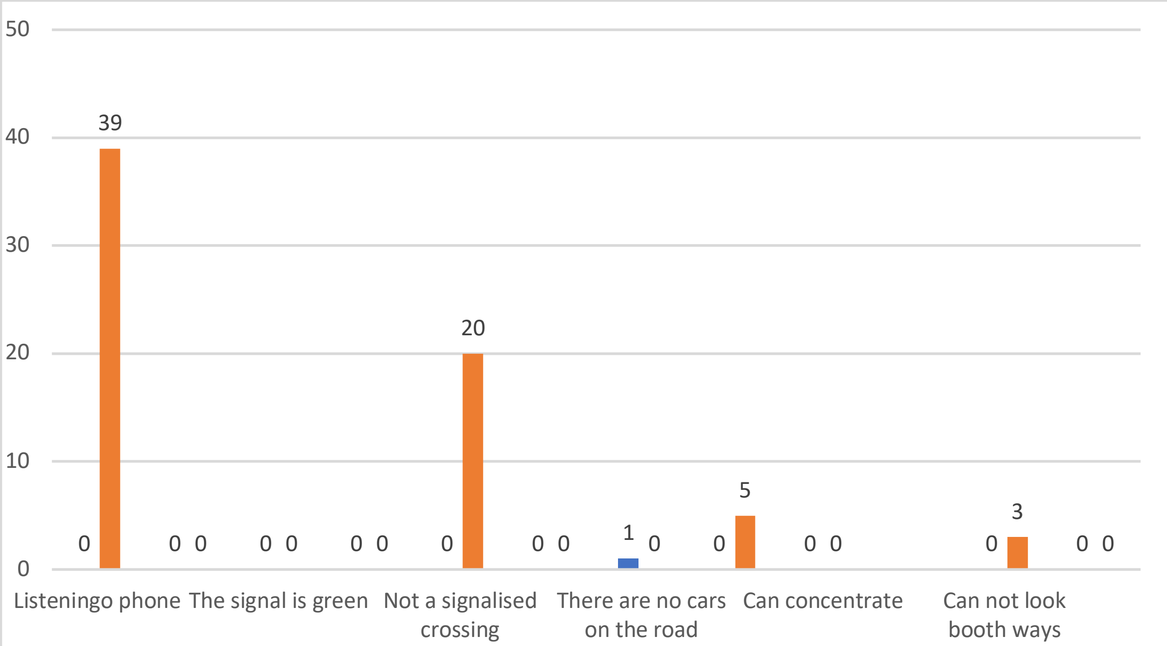
Figure 4.14 (below) shows that 41 participants who were aware of the risks of looking at a mobile phone when crossing the road stated that it was safe to cross when looking at a mobile phone at the "green person" signal, and gave the presence of the green signal as the reason for their answer. Conversely, two participants who stated that it was not safe to cross the road when looking at a mobile phone at the "green person" signal gave the presence of the green signal as the reason for their answer.

Figure 4.15 (below) shows that 22 participants who were aware of the risks of looking at a mobile phone when crossing the road stated that it was not safe to cross a road with no signal light when looking at a mobile phone, and gave the absence of a signalled crossing as the reason for their answer. Likewise, seven participants stated that it was not safe to cross a road with no signal light when looking at a mobile phone and gave the inability to look both ways as the reason for their answer. Finally, 11 participants stated that it was safe to cross a road with no signal light when looking at a mobile phone and gave the absence of cars on the road as the reason for their answer.



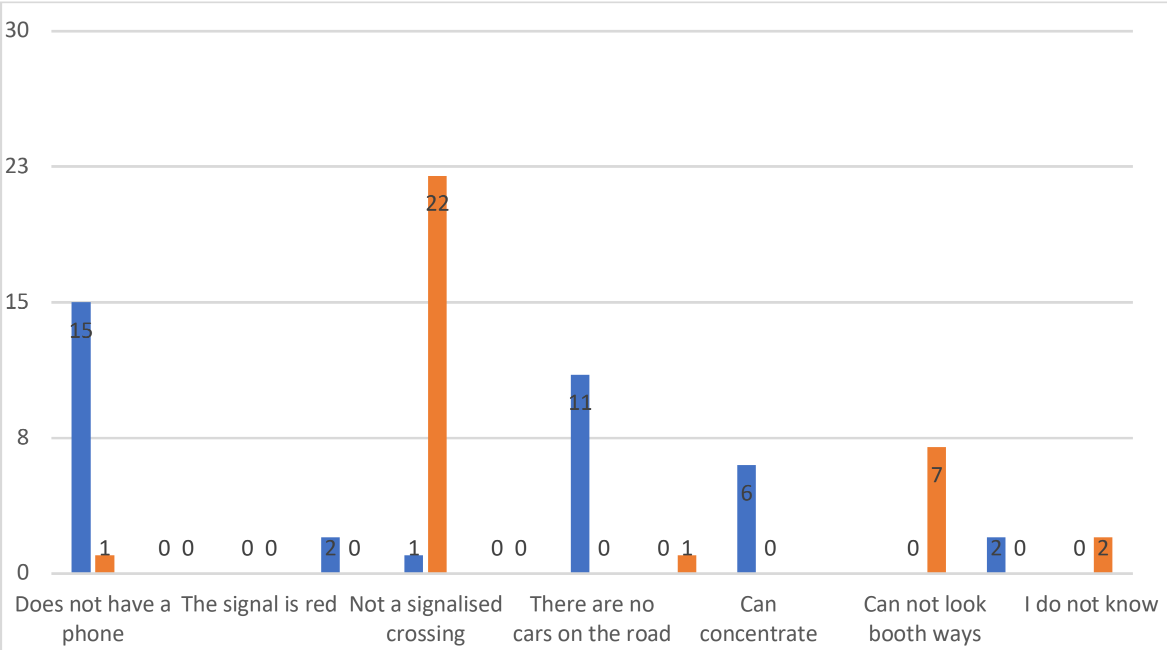
yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 15: 4.13: Looking at a mobile phone with a "red person" signal light



yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 16: 4.14: Looking at a mobile phone with a "green person" signal light



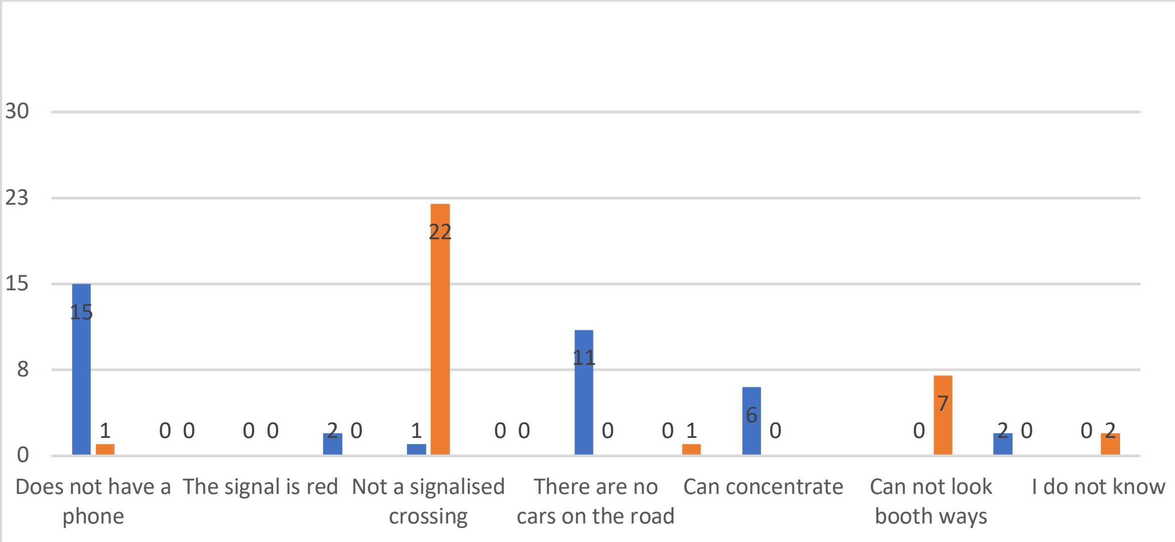
yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 17: 4.15: Looking at a mobile phone with no signal light

Figure 4.16 (below) shows that 43 participants who were aware of the risks of having no mobile phone when crossing a road with a "red person" signal stated that it was unsafe to cross a road with a “red person” signal while not holding a mobile phone, and gave the red signal as the reason for their answer.

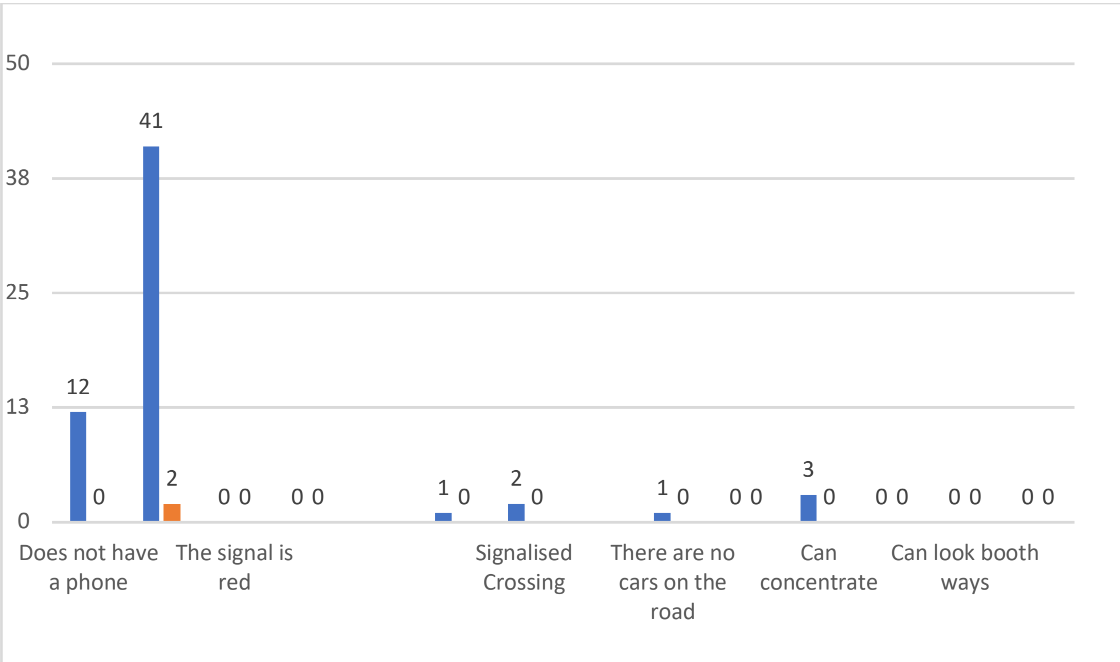
Figure 4.17 (below) shows that 41 participants were aware of the risks of no mobile phone when crossing the road with a “green person” signal, and stated that it was safe to cross with no mobile phone at a “green person” signal, giving the green signal as the reason for their answer. Additionally, 12 participants stated that it was safe to cross with no mobile phone at a “green person” signal and gave the absence of a mobile phone as the reason for their answer.

Figure 4.18 (below) shows that 22 participants were aware of the risks of having no mobile phone when crossing a road. These stated that it was not safe to cross a road without a signal light with no mobile phone and gave the absence of a signalled crossing as the reason for their answer. Furthermore, five of these participants stated that it was safe to cross a road with no signal light with no mobile phone and gave the absence of the mobile phone as the reason. Finally, 11 participants stated that it was safe to cross a road with no signal light with no mobile phone and gave the absence of cars on the road as the reason for their answer.



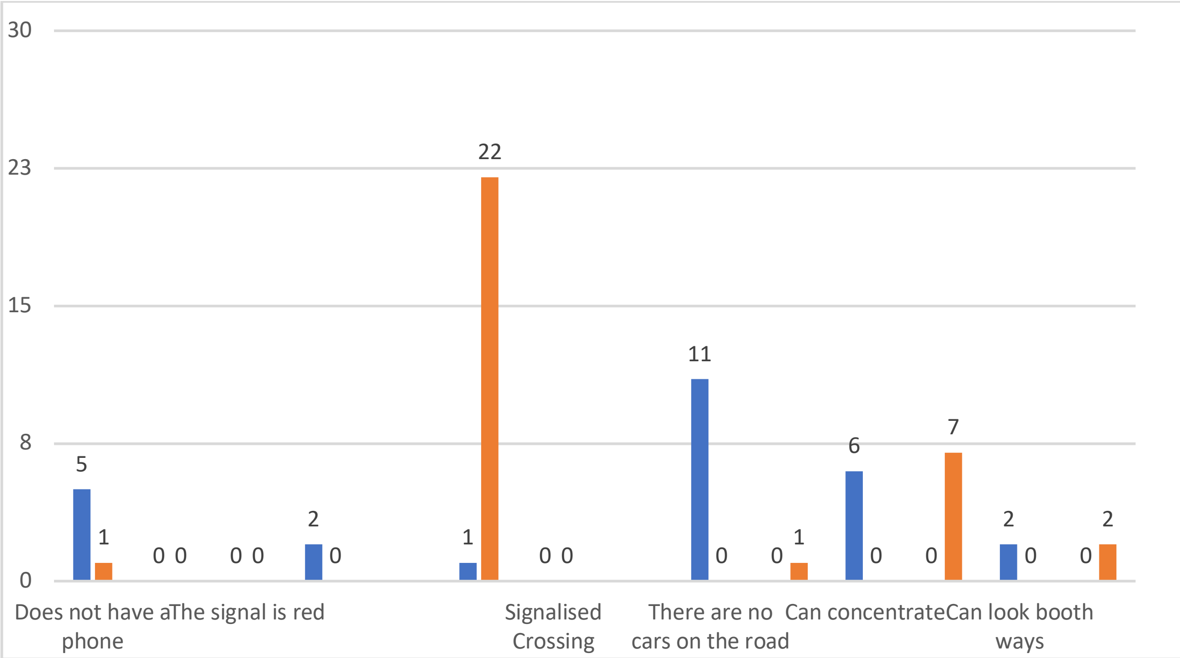
yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 18: 4.16: No phone at "red person" signal light



yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 19: 4.17: No phone at "green person" signal light



yes it is safe to cross' (blue columns) and 'no it is not safe to cross' (orange columns) answers.

Figure 20: 4.18 No phone at no signal light

4.4 Summary

The first section of the analysis focused on analysing the effect of mobile phone distractions on attention to changes in pedestrian scenes. No significant effect of distraction was found in correct identifications and response times.

Attention to changes was faster and more accurate for changes that were relevant to pedestrians (such as signals and the presence of cars) than for changes to other parts of a scene (such as buildings and shop windows). It was observed that the number of correct responses did not vary significantly among different age groups or between genders. There was no significant correlation between relevant pedestrian changes, including long-term self-regulation, short-term self-regulation, chronological age, the Balloon Analogue Risk Task (BART), and mean response time of not-pedestrian-relevant changes.

The second part of the analysis focused on analysing the recognition of danger in photographs of a person crossing a road with or without a phone. This experiment was conducted to determine whether adolescents think it is safe to cross a road the reasoning behind their answers. The type of phone use compared in the experiment was portrayed in four types of photographs: no phone, listening, looking and holding. Their safe/not safe decisions were not related to risk-taking, self-regulation, age, gender or mobile phone ownership. This suggests that these variables do not result in individual differences in road safety awareness. Reasons for deciding that crossing a road was not safe were road sites (red signal light, green signal light, no signal) and mobile use while crossing (holding a phone, listening to a phone, looking at a phone and no phone use).

Adolescents' awareness of whether using a mobile phone at the roadside is safe or not was affected by the type of phone use. Looking at the phone and listening to the phone were rated as less safe than holding the phone. The reasons given suggested that participants' understanding of the distractions caused by mobile phones were not consistent. When there was no light signal, most participants gave reasons that were related to distraction caused by the phone. Where there was a light signal, more reasons were given regarding the light signal than the phone.

4.5 Limitations and recommendations for further research

In comparing the observational study and the experimental studies there is a discrepancy in the number of participants involved. Although the actual number of participants directly observed was greater in the observational study than the experimental study, the number of actual road-crossing events per participant was still relatively low in the observation study. Most of the time it was typically the case that each 'road-crossing' event involved a unique participant. In contrast, participants in the experimental study were tested multiple times during a testing session with multiple trials used to arrive at a measure of performance using a battery of tests. In this way the experimental studies actually might have involved more events in sum. The results from the experimental study confirmed that the participants were aware of the dangers of using mobile phones during road crossing. Nevertheless, there are some limitations to the conclusions that can be drawn. The experimental study employed an opportunity sample that was small in comparison to the observation study. They therefore lack the power that might be associated with the observation study. This is because the observation study is very comprehensive and based on a large number of observations. Future research directions should aim to recruit larger sample sizes in the exeperimental investigations.

4.6 Conclusion

The experiments in this chapter show that this cohort of adolescents were not affected by mobile phone distraction in controlled, experimental conditions. This suggests that adolescents were able to ignore distractions when focusing their attention on a task. Further, most of the adolescents involved in this project were aware of the dangers of using a mobile phone at the roadside, but their reasons were not always related to the phone itself. This information may be useful in designing road safety education programmes. With this context in mind, the next chapter explores the availability of safety education materials about pedestrians and mobile phones for adolescents.

Chapter 5. Content analysis of internet advice about mobile phone risks for adolescent pedestrians

5.1 Introduction

This chapter focuses on a content analysis regarding the risks to pedestrians of using a mobile phone when crossing a road. Chapter 3 found that mobile phones were a distraction that affected pedestrian behaviour while crossing the road, while Chapter 4 found that adolescents are capable of ignoring some types of mobile phone distractions and are aware of the dangers to pedestrians of using mobile phones on the roadside. Reducing traffic-associated harm to young people has been the focus of numerous initiatives by public health professionals. As Schwebel et al. (2018) clarified, seeking to change young people's conduct has also been a recent point of emphasis. Not only is the problem posed by mobile phone use a significant distraction for drivers, but many adolescents continue to use their mobile phones around moving vehicles as pedestrians, regardless of their greater level of involvement in traffic accidents.

Peden et al. (2009) and Underwood (2005) found that adolescents who utilise mobiles while walking across roads had limited instructional intercessions aimed at them. Therefore, the extent to which mobiles and additional hand-held electronic apparatus, with the potential to result in diversion of attention, is the focus of instructional and learning initiatives provided to adolescents is the focus of this research. Through altering young people's conduct, the chance of harm may be reduced, highlighting the need for the fundamental principles of traffic safety to be conveyed to children and adolescents. By studying, recalling and adhering to safety guidelines, young people are able to take partial responsibility for their own welfare.

Because online platforms may be utilised to widely disperse information relating to health and safety, the previous twenty years has seen a development from educators and parents being the major providers of knowledge to greater adoption of lessons delivered by technological aid. Practising appropriate conduct and acquiring safety knowledge can be successfully carried out online and, therefore, young people utilising such online platforms could see a strong beneficial impact. The main aim of the current study was to assess whether advice pertaining to mobile phone use for pedestrians is included on non-UK government agencies and UK government agencies' on-line platforms, aimed at educators, parents, teachers and adolescents. This chapter reports a content analysis of a range of road safety organisations' websites.

5.2 Method

5.2.1 Search strategy

As the analysis focuses on advice for UK road users, European and international websites were excluded. General road information such as road engineering, public transport, publications, reports and statistics, was also not included. Moreover, websites advertising books and magazines were not included. Websites written in the English language were sampled and those not in English were excluded.

5.2.2 Sample

A sample of 40 UK road safety websites was selected. These include 13 websites for the main relevant UK Government departments (Department for Transport, Department for Education and Department for Health) of the governments of England, Wales, Scotland and North Ireland. Local government (city council) road safety websites (n = 8) of the capital cities of the UK counties were also included: London (England), Edinburgh (Scotland), Cardiff (Wales) and Belfast (Northern Ireland). A further four urban areas were selected (Manchester, Birmingham, Sheffield and Nottingham). Rural areas in England were chosen based on their geographical location and high traffic collision rates (Lincolnshire, Leicestershire, Northumberland, Kent, Hertfordshire, Devon and Somerset). In addition, 12 websites were UK-based road safety organisations and charities; The Royal Society for the Prevention of Accidents (RoSPA), Road Safety GB, Brake, 2PASS, CAPT, Child Accident Making the Link; Road Safety Foundation; Drive Save; FIA Foundation, Living Street and Sustrans.

5.2.3 Materials

A checklist was used to quantify the types of advice featured on each website (see appendix 5.1). The following information was extracted from each website: distraction types (phone, music player, headphones, other portable electronic devices); age group (child, adolescent); user (teacher, parent, child/adolescent); type of road user (pedestrian, cyclist, scooter-user); format (lesson plan, event, campaign, course, workshop, advice or recommendation, programme, guidance, study unit ,teaching notes); materials and resources (posters, music, PowerPoint, video or film, photograph or picture, worksheet, test or quiz, safety equipment);

activity (take out, discussion of personal experience, discussion, playing games, writing about safety, making a poster or similar product, reading, selecting an answer, watching a video or film, walking, training, imagine a journey, drawing a picture). Qualitative information about the safety messages were also noted for each website. Definitions of key terms and some examples are provided in Appendix 5.2

5.2.4 Procedure

Data was collected in stages starting in February 2017. First, each homepage was analysed for information or advice about the phone or other electronic distractions. Home- pages were coded as either (1) includes advice about phones and other electronic distractions or (2) does not include advice about phones or other electronic distractions. Second, each website was searched using the following keywords: road safety, pedestrian, walking, road crossing, cycling, scooter, adolescence, adolescent, child, children, phone, Key stage 2, Key stage 3, and distractions. The checklist was used to collect data about distractions from using portable or electronic devices such as phones, MP3 players and headphones. Other distractions, such as distractions from friends chatting, mood, weather conditions, eating or drinking, map reading, pets and emergency vehicle sirens, were not analysed. Guidance for adult road users, drivers and motorcyclists was not analysed. Following the website search, each website was coded as either (1) includes advice about phones and other electronic distractions or (2) does not include advice about phones or other electronic distractions. The type of distraction was coded, the age range of the road user to whom the advice pertained (child, adolescent or both), whether it was for child, teacher or parent use, the type of road user (pedestrian, cyclist, etc.) and the format of the advice and resources. Finally, the links to other websites were noted and then analysed using the keywords.

5.2.5 Ethics

The University of Lincoln Research and Ethics Committee approved this study.

5.2.6 Coding reliability

A sample of 10 websites, three of which mentioned phone distraction, were analysed by a research assistant and the results compared with the results obtained by the researcher. The agreement percentage was 75%.

5.3 Results

This section reports the results presented in the form of three sections. Section 5.3.1 reports the results of 40 home- pages of the websites. Further, Section 5.3.2 provides detailed results for all 40 websites. Meanwhile, Section 5.3.3 features an analysis of websites having information regarding the distractions generated from electronic devices.

5.3.1 Analysis of websites' homepages

None of the homepages included information about relevant distractions. A total of 33 websites did not include advice or information about distractions from mobile phones or other electronic devices, but some contained advice and information about road safety in general (such as for pedestrians, cyclists and skaters).

5.3.2 Analysis inside the websites

The majority of websites did not include advice or information about mobile phone distractions or distractions from other electronic devices, significantly more than expected by chance. Only seven websites contained information regarding the electronic distractions caused by music players, headphones, mobile phones and certain other electronic distractions (including multiple distractions). For mobile phones, $\chi^2(1) = 19.60$, $p< 0.001$; for music player distractions, $\chi^2(1) = 22.50$, $p< 0.001$; for electronic devices distractions, $\chi^2(1) = 36.10$, $p< 0.001$; for distractions from using headphones, $\chi^2(1) = 28.90$, $p< 0.001$. A slightly higher proportion of local government websites for rural areas contained information and advice about mobile phone distractions and other types of relevant distractions than the city/local government websites, national government websites or charity and NGO websites (see Table 5.1).

Table 26: 5.1: Number of organisations with advice about phone and electronic distractions on their websites

	Mobile phones		Music players		Other electronic devices		Headphones	
	Advice	No advice	Advice	No advice	Advice	No advice	Advice	No advice
National government websites	1	12	1	12	0	13	1	12
Local government (rural) websites	3	4	2	5	1	6	2	5
Local government (city) websites	2	6	1	7	0	8	0	8
Charity and NGO websites	1	11	1	11	0	12	0	12
Total	7	33	5	35	1	39	3	37

5.3.3 Analysis of additional links within websites

There were many links provided on each site. For example, the "THINK" site was linked by many of the 40 sites studied. The information provided does not focus on distractions but more generally on road safety for young people. None of these websites included information about relevant distractions for child and adolescent road users, with the exceptions of the London website and Northumberland, which did provide links to the "Road Safety GB" site which provided information about these types of distraction, specifically music players and headphones.

Analysis by target audience

Over half of the websites contained advice or information for children, while only a third of websites gave advice or information for adolescents (see table 5.2).

Table 27: 5.2: Number of websites containing advice or information for different age groups

Age	Number of websites
Child < 9 years	21
Adolescent >10 years	7
No specific age (child& adolescent)	12

Table 5.3 shows that slightly more websites gave advice to cyclists than pedestrians. Moreover, advice for skaters was provided on the fewest websites.

Table 28: 5.3: Number of websites containing advice or information for different types of road users

Road users	Number of websites
Pedestrians	18
Cyclists	20
Skaters	8
General road safety	11

As shown in Table 5.4, the majority of websites included advice and information for teachers.

Table 29: 5.4: Number of websites containing advice or information for type of person

Type of person	Number of websites
Teachers	20
Parents	18
Children & adolescents	14

Types of resources and materials

Each site contains a source of information containing materials used to conduct awareness activities for children and adolescents. The most frequently included resource was a lesson plan, provided by 13 sites, and campaign, provided by 10 websites. The third most common was top tip or recommended with nine (see Table 5.5).

Table 30: 5.5: Number of websites containing different resources

Type of resources	Frequency of websites
Lesson plan	13
Event/day/week	2
Campaign	10
Course	7
Workshop	1
Top tip/recommend	9
Programme/scheme	6
Guidance/ school role	8
Study unit	2
Teaching notes	1

Table 5.6 shows the different types of teaching and learning materials that were included with film/video occurring the most frequently.

Table 31: 5.6 shows the different types of teaching and learning materials included with film/video occurring the most frequently.

Teaching and learning resources	Number of websites
Advertisement/ banner	7
Music/song	1
PowerPoint/slides	3
Film/ video	11
Game	7
Story book	6
Test/quiz/task sheet	5
Teaching tools recommended (e.g., bike, gadget, role-play, safety equipment, laptop)	7

Different activities, such as training and practising, were used with other activities such as talking, discussion, questions and presentations (See Table 5.7).

Table 32: 5.7: Types of activities described in the websites

Activity	Frequency of Websites
Outdoor activity	3
Speaker/ personal experience	2
Talking/ discussion/ ask question/ presentation	12
Play game	9
Write (story)	1
Making (poster)	2
Select	1
See/watch/show	5
Training/practice	17
Read book	3
Image (journey)	1
Draw	1
Think (about when you walk)	1

5.3.4 Analysis of 7 websites with information about mobile phones and other electronic distractions

Analysis of distractions types:

Mobile phone distraction

More websites offered advice regarding distractions from mobile phones to adolescents in comparison to children. For example, six websites offered advice to adolescents on distractions from the mobile phone and other portable devices, while only three websites offered the same advice to children. Moreover, only two websites offered advice to the skaters, which was the lowest number (see Table 5.8).

Table 33: **5.8: Mobile phone distraction advice for child and adolescent pedestrians, cyclists and skaters**

Mobile phones	General information about road safety and mobile phones			Information is about pedestrians and mobile phones			Information is about cyclists and mobile phones			Information is about skaters and mobile phone		
Websites Frequency	**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**
These are the websites that include advice aimed at children about using mobile phones	4	3	0	5	2	0	6	1	0	7	0	0
These are the websites that include advice aimed at adolescents about mobile phones	1	6	0	1	6	0	5	2	0	5	2	0

*0 = No information/advice on the website
1= These websites contain one piece of information
2= These websites contain two pieces of information

Music player distraction

On comparing the advice offered to children and adolescents about distraction from using music players when crossing the road, it was noted that the adolescents were given more advice than the children on six websites (see Table 5.9).

Table 34: **5.9: Music player distraction advice for child and adolescent pedestrians, cyclists and skaters**

	General			Pedestrians			Cyclists			Skaters		
Frequency of information*	0	1	2	0	1	2	0	1	2	0	1	2
Websites with advice for children	5	2	0	6	1	0	6	1	0	0	0	0
Websites with advice for adolescents	1	4	2	2	4	1	4	2	1	5	2	0

*0 = No information/advice on the website
1= These websites contain one piece of information
2= These websites contain two pieces of information

Electronic devices distraction

Nothing was found about distraction from electronic devices (see Table 5.10)

Table 35: **5.10: Electronic devices distraction advice for child and adolescent pedestrians, cyclists**

	General			Pedestrians			Cyclists			Skaters		
Frequency of information*	**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**
Websites with advice for children	7	0	0	7	0	0	7	0	0	7	0	0
Websites with advice for adolescents	7	0	0	7	0	0	7	0	0	7	0	0

*0 = No information advice on the website
1= These websites contain one piece of information
2= These websites contain two pieces of information

Head- phones distraction

The majority of websites provided advice about headphones distracting adolescent pedestrians while walking or crossing the road. There was no advice for children (see Table 5.11).

Table 36: **5.11: Headphone distraction advice for child and adolescent pedestrians, cyclists and skaters**

	General			Pedestrians			Cyclists			Skaters		
Frequency of information*	0	1	2	0	1	2	0	1	2	0	1	2
Websites with advice for children	7	0	0	7	0	0	7	0	0	7	0	0
Websites with advice for adolescents	1	0	6	1	6	0	7	0	0	7	0	0

*0 = No information advice on the website
1= These websites contain one piece of information
2= These websites contain two pieces of informatio

5.4 Summary

The results indicate that advice about distraction resulting from mobile phones was included in only seven of the 40 websites. The majority of websites did not include advice or information about mobile phone distraction or distraction from other electronic devices for children and adolescents as pedestrians, significantly more than expected by chance, with information on the websites and in research relating in greater part to mobile phone use by drivers.

Most of the results regarding advice and information from the websites included in this study support the view that there is a lack of information for educating children and adolescents about the potential dangers of distraction caused by using mobile phones and other electronic devices such as iPads, (Peden, 2008; Underwood, 2005). For identifying road-crossing sites quickly and accurately, especially for children and adolescents, the road safety training programmes need to take into account the development of knowledge and culture of the adolescents concerned.

The findings of the research reveal that local government websites for rural areas were more likely than other websites to contain advice and information regarding distraction resulting from mobile phone use and other kinds of relevant distractions. In addition, only a small proportion of all relevant websites included advice about distractions caused by mobile phones and other electronic devices. More than half of the websites did not give any advice or information about children and adolescents. The websites mentioned distraction, pedestrian, cyclist and general road safety only once on average. Websites mentioning phone distraction also seemed to focus less on material and resources. The 12 types of activities recommended for learning about distractions were outdoor sessions, personal experience, discussion, play, writing story, making something, select, watching or viewing, training, reading, imaginary journey, walk, think and draw.

Additionally, it was noted that there was more advice for adolescents on the websites regarding the distraction caused by mobile phones while crossing the road than that for children mentioning mobile phone distraction.

Skaters received the least advice about distraction, as they are usually very young, and scooter users are often accompanied by their parents on the road. However, because adolescents prefer to cycle alone, the information on those websites about cyclist safety was more prevalent.

There is an increasing number of programmes on road safety websites about using bicycles, especially for young children. For example, the sites advise as to what children should do while they cycle on the street, such as wearing bright clothes to be seen by car drivers. While the advice for adolescent pedestrians was limited, most of the websites offered videos or films about the potential for accidents and injuries caused by distraction from mobile phones or other electronic devices, with the websites most frequently using materials to educate children and adolescents.

However, some of the websites did not contain any information with regards to mobile phone distraction of pedestrians or cyclists, with information instead being focused on cars or drivers, or simply general advice about road safety. It is generally the case that the results of the study provided relevant information in relation to the target data, which sought to identify what was being offered to children and adolescents regarding the distraction caused by portable electronic devices while they are on the road. Despite the fact that not all the included websites offered the required advice, the majority of these websites offered some general practical advice on distraction. This advice can be used as educational tools for children and adolescents in order to improve their attitudes and, consequently, their behaviour on road, leading to greater safety while on the road.

5.5 Limitations and recommendations for further research

The main limitations of this study are that the sample size, which was 40 websites, of which only seven contained advice for adolescents about distractions resulting from using a mobile phone and other electronic devices, which is a small proportion. Future research may need to find more information about advice from sources other than websites. Road safety officers, who are hired by the UK Government to deal with road safety, and road safety education officers, who are appointed to teach people about road safety, could be contacted and surveyed for information regarding their knowledge of road safety and distraction resulting from mobile phones.

5.6 Conclusion

In conclusion, the majority of websites did not feature advice or information about mobile phone distractions or distractions from other electronic devices for children and adolescents as pedestrians, significantly more than expected by chance. There is a need for more road safety education messages aimed at this topic because of the high rate of pedestrian accidents caused by distraction and the popularity of mobile phones among adolescents.

The results of this study could be helpful for parents in influencing their children's behaviour on the road and encouraging them to walk without using mobile or other electronic devices such as iPads. Therefore, any subsequent study should aim to investigate adolescents' opinions about road safety messages. This may help create new programmes that educate parents and teachers on how to improve their children's knowledge on road safety and directly for the adolescents.

Chapter 6. Adolescents' opinions about road safety training linked to the risks of mobile phone use for pedestrians

6.1 Introduction

The previous chapter provided a content analysis study of websites focusing on advice for adolescent UK pedestrians using a mobile phone on the road. At the time of the study, there was a dearth of advice freely available on major stakeholder websites. The aim of Chapter Six is to investigate adolescents' opinions about a selection of pedestrian safety information regarding mobile phones using the interview method. It also seeks to discover what they view as the most efficient ways of informing adolescents about the risks of using mobile phones when crossing a road. This may prove beneficial for the design and implementation of road safety training, while the interviewees' ideas could support institutions such as schools and road safety educators.

6.2 Method

6.2.1 Sample

A total of 21 young people (6 females and 15 males) volunteered to participate in this study in 2019. The age range was 11–17 years, with a mean age of 13.96 years. The mean age of the female participants was 13.67 years and the mean age for males was 14.07 years. Snowball sampling was used to obtain the sample.

6.2.2 Materials

A questionnaire was developed and piloted on a small sample of adolescents who were not participants. The questionnaire was divided into two sections, with the first section including questions about participants' demographic information (i.e. age, gender and mobile phone ownership) and the second section taking the form of an open-ended question: "What do you think will be a good way to teach young people of your age about the dangers of using a mobile phone while crossing the road? You can be as creative as you like." Accordingly, the participants were provided with an A4 piece of paper to write their answers and were shown five examples of road safety training via a laptop computer, chosen from the road safety websites. These websites were included in the previous content analysis study and were specific to use of mobile phones at the roadside. These examples were as follows:

(1) A short film, namely "Road Ready? Expect the Unexpected"[1] from the Department for Transport, THINK: The film showed children at the roadside displaying risky behaviour, including using a mobile phone. As a result of this behaviour, a man stopped the children and gave them advice to correct their potentially dangerous behaviour (Advised by having an adult talking and explaining potential dangers).

(2) "It's cool, it's not cool": a short film showing a young person illustrating her knowledge of road safety by drawing on a white board to show the possible dangers, including using a mobile phone (advised using drawings).

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[1]https://vimeo.com/268811066?from=outro-embed

(3) A short game - “Take the Lead”[2] (advised people using an electronic game) from the Department for Transport’s THINK. a game in which two friends choose a safe way to cross a road.

(4) Three posters named “Teen Pedestrian Safety: Crossing the Street”[3] (advised people using posters) that are produced by the Prevent Child Injury organisation. These posters feature a young person shown in several scenarios with safe or unsafe road crossing behaviours listed. These are accompanied by written advice designed to remind parents about different aspects of education for their children to remain safe on the road.

(5) A short film named “Road Crossing VR Google Cardboard 3D”[4] (Advised people using a 3D film and glasses) from YouTube. This film talks about road safety using virtual reality glasses to experience the film in a more realistic way.

6.2.3 Procedures

Participants were met by the researcher at a date and time and in a safe environment agreed with the participants’ parents. The researcher provided the participants and their parents with information sheets and consent forms. In addition, the participants were reminded of their right to withdraw from the interview at any time. Firstly, participants were asked, “What do you think would be a good way to

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[2] https://vimeo.com/268816866

[3] https://www.flickr.com/photos/141879303@N06/sets/72157683213948772/with/36025500395/

[4] https://www.youtube.com/watch?v=iyWRWKCtnAQ

teach people of your age about the dangers of mobile phone use while crossing a road? You can be as creative as you like." Secondly, the participants were provided with five examples, with each one of them having different material and objectives as described in the previous section (See section 6.2.1). The participants in this stage were asked to rank these five examples from one to five (where one is best and five the worst) based on the preferences of participants with respect to attractiveness and effectiveness for their age group. Finally, they were asked about their age, gender and mobile phone ownership, thanked, debriefed and reminded about how to withdraw their information at any time if necessary. There was no time limit. Participants took between 15 and 45 minutes and no participants were stopped because they took too long.

6.2.4 Data analysis

A descriptive statistics method was used to find out what reason participants gave for their answers.

Question 1: "What do you think will be a good way to teach young people of your age about the dangers of using a mobile phone while crossing the road? And why?

Answers were read several times and then coded using the categories shown in Table 6.1 and Table 6.2

Table 37: 6.1: Coding categories and examples of methods for teaching road safety suggested by the participants

Coding category	**Example**
Poster	Put poster in public places
Talk	Advise people by talking to them
Video	Play video about incidents

Table 38: 6.2: Reasons given by participants for their choice of road safety education methods

Coding category	**Example**
Convincing	It is easy to convince them
Impressed	I like this education method
Explanation	I can explain more about the issue
Understanding	It is easy to understand this method
Realistic	Close to real life
Presentation	Can put it in any place
Do not know	I do not know
Attractive	Draws people's attention

Question Two:

Could you rank the methods/types in order from the most (most effective and useful in discouraging adolescent mobile phone usage on the road) to the least? Rankings were in order of most effective, with one for the most effective and five for the least effective. Reasons for choice of order were categorised as follows (see Table 6.3).

Table 39: **6.3: Reasons for ordering the five road safety examples from most to least effective**

Coding category	**Examples**
Convincing	It is easy to convince them
Impressed	I like this education method
Explanation	I can explain more about the issue
Understanding	It is easy to understand this method
Realistic	Close to real life
Presentation	Can put it in any place
Do not know	I do not know
Attracting	Draws people's attention
Self-educational	Can teach himself/ herself
Boring method	Can't complete it because it is boring
Uncomfortable	Uncomfortable glasses
Not Impressed	I do not like it

6.2.5 Coding reliability

A sample of six participants' answers were analysed by a research assistant and the results compared with the results obtained by the researcher. Using an intraclass correlation coefficient (ICC) to measure the agreement in the answers between the participants, the ICC was found to be 0.874; namely the agreement between researcher and research assistant reaches 87.4%.

6.3 Results

6.3.1 Answer question one

This question asked to the participants was, "opinion about what will be a good way to teach young people of their age about the dangers of using a mobile phone while crossing the road? And why?" Figure 6.1 shows that about half of the participant answers considered advice played on video about incidents was the most effective way to advise about the risks of using a mobile phone on the road (43%), while the proportion of respondents who believed the most effective advice was via talking to them was 29 % and then the poster at 28 %.

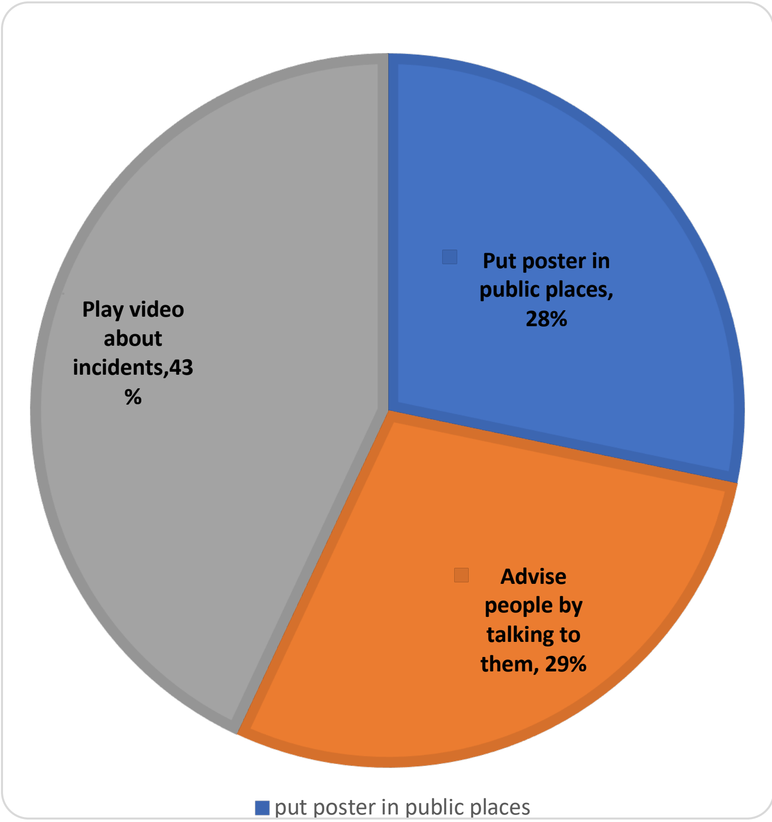

Figure 21: 6.1: Adolescent Opinions about the Most Effective way to advise about Risk of Using Mobile Phone on the Road

Figure 6.2 Shows that the most effective reasons were, *I can convince them, I can explain more, easy to understand* with 24%, 19% and 19% respectively. These were followed by other reasons that were mentioned less frequently compared to the previous three reasons. The participants only gave one answer to this question.

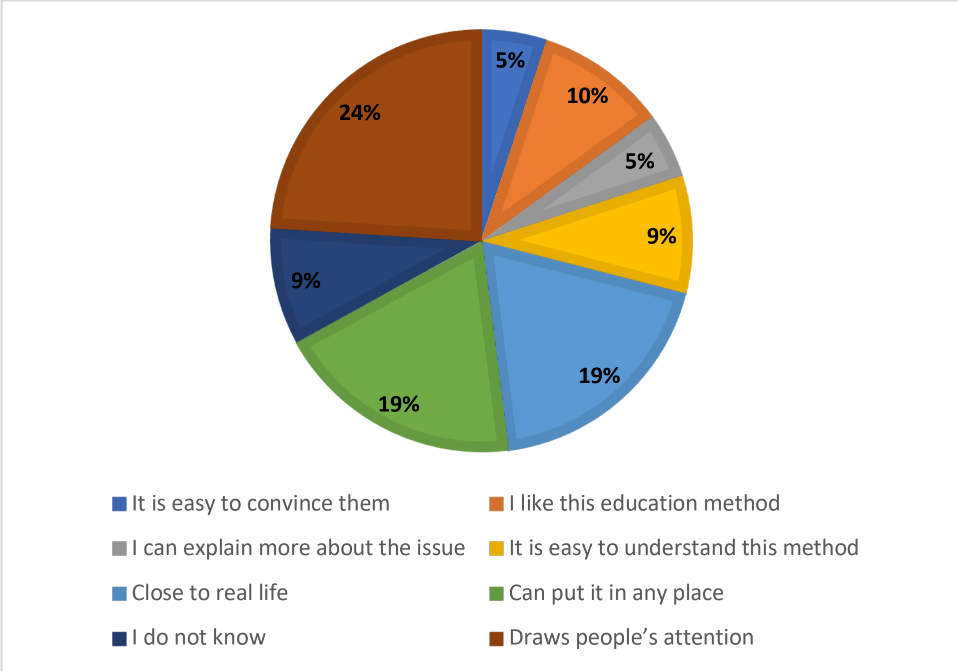

Figure 22: 6.2 Reasons given by participants for the most effective way to advise about risk of using mobile phone on the road

6.3.2 Answer question two

This question tested the participant's ranking of the methods/types in order from the most (more effective and useful in discouraging adolescent mobile phone usage on the road) to the least. From Table 6.4, more than half of participants 52.4% selected advice by talking as their first choice, while 33% classified it as the second. About 33% of participants selected advice using drawings (the second) as their most preferred method/types. Electronic games were the fourth preference by 42.9% participants. Poster/written advice was classified fifth by 47.6% of participants.

Table 40: **6.4: The distribution of the methods/types**

	First choice (most effective)		Second choice		Third choice		Fourth choice		Fifth choice (least effective)	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Advice by talking	11	52.4%	7	33.3%	2	9.5%	1	4.8%	0	0.0%
Advice using drawings	7	33.3%	3	14.3%	6	28.6%	4	19.0%	1	4.8%
Advice using electronic games	0	0.0%	7	33.3%	2	9.5%	9	42.9%	3	14.3%
Advice using posters	0	0.0%	4	19.0%	5	23.8%	2	9.5%	10	47.6%
Advice using 3D film	3	14.3%	0	0.0%	5	23.8%	6	28.6%	7	33.3%

Table 6.5 shows that advice by talking was ranked as the most effective type for the adolescent age group when compared with other types such as posters, 3D glasses and electronic games.

Table 41: 6.5: The participant rank of the methods/types

	Mean Rank	Range
Advised people by talking to them	1.67	1 – 4
Advised people by drawing	2.48	1 – 5
Advised people using electronic games	3.36	2 – 5
Advised people using posters	3.86	2 – 5
Advised people using 3D film glasses	3.64	1 – 5

A Friedman test was used to compare the ranks of the five examples of road safety information and a significant difference was found (χ^2 = 28.019, df = 4, N = 21, $p < 0.001$).

Advice by talking to people represented the first choice according to participants' opinions, with a mean rank of 1.67. The second most preferred method was advice using drawings, with a mean rank of 2.48. The other three were closely ranked (advise people using electronic games, advise people using 3D film glasses and advise people using posters), which had mean ranks of 3.36, 3.64 and 3.86 respectively.

6.3.3 Differences between male and female opinions

Table 6.6 shows that there were differences between male and female opinions in the choice of advised people by talking to them and advised people using drawing. For both males and females, advised people by talking and drawing received a higher rank than other types/methods. There were apparent differences between male and female opinions in the choice of advised people by talking. The male score of 1.33 for Road Ready means that most of the males thought it was the best. The female score of 2.50 for Road Ready means it is their second/third best of the five examples. This difference was statistically significant using the Mann-Whitney test (Z=2.58, p =0.01).

Table 42: 6.6: Descriptive Statistics and the Mann-Whiney test for Gender

	Female		**Male**			
	Mean	Range	**Mean**	Range	Z	p-value
Advised by talking	2.50	1 – 4	1.33	1 - 2	2.579	.010
Advised using drawings	2.00	1 – 4	2.67	1 -5	1.048	.294
Advised using electronic game	3.00	2 – 5	3.53	2 -5	.953	.341
Advised using posters	3.83	2 – 5	3.87	2 - 5	.000	1.000
Advice using 3D film	3.67	1- 5	3.67	1 - 5	.080	.93

6.3.4 Reasons for ranking the five examples

Figure 6.3 shows that the most repeated reasons for the most effective ranked methods were, *I like this education method, it is easy to understand this method*. On the other hand, the reasons *I do not like it, I can't complete it because it is boring* were reasons most frequently given for the last rank.

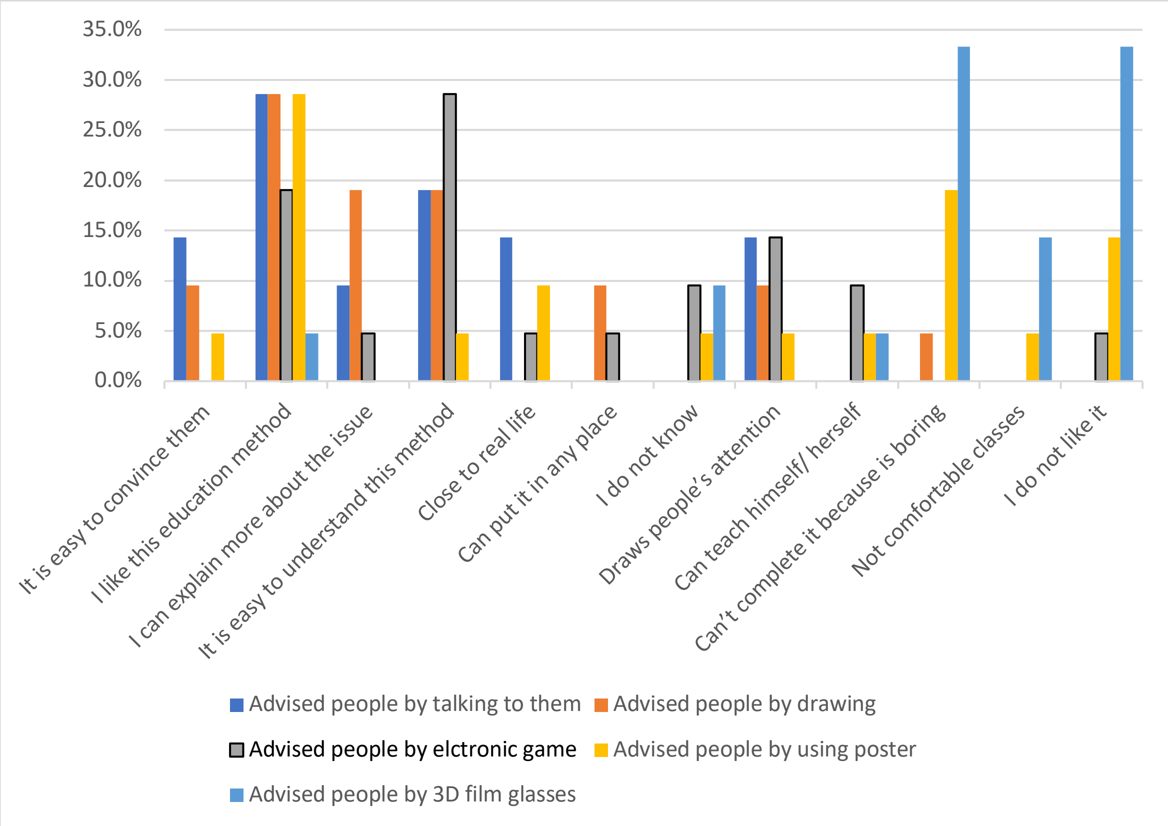

Figure 23: 6.3 Reasons for ordering the five road safety examples from most to last effective

6.4 Summary

The data gathered from the investigation was aimed at gaining data on the methods adolescents consider to be most effective by ranking the methods/information types in order from the most effective (i.e. those that discouraged mobile usage on the road), to the least effective. The findings obtained were analysed with the help of the descriptive analysis method.

In respect of the first question regarding the method that the adolescents found most appropriate to teach young people like them about the dangers of mobile phone usage, the three methods that were commonly stated by the respondents were the use of posters in public places, advising people by talking to them and broadcasting videos illustrating the hazardous incidents. In this respect, the majority of the respondents (42%) identified talking to them as the most effective method while 28% of the respondents preferred posters and another 29% of the respondents selected videos.

Furthermore, the most frequent reasons given by the respondents regarding the choice of methods on road safety education were that an issue could be explained using the selected method and that it would be easy for them to understand the issue using the selected method. The respondents also noted that the selected method was close to a realistic presentation of life, the selected method could be put in any place, the selected method was more attractive in drawing the attention of the people and that the selected methods could be helpful in self-education. However, some respondents also stated that they did not know. In this respect, 24%, 19% and 19% respondents voted for the reasons: ‘I can convince them’, ‘I can explain more’ and ‘easy to understand’ as the key reasons, respectively. Figure 6.2 shows 9% for ‘I do not know the key reasons.’

In respect of the second question that examined the ranking of the methods in the order that the participants found most effective in gaining awareness about the practice of road safety, 12 reasons were highlighted by the respondents. These were the ease with which they could convince them, liking for the educational method, potential to explain more about the issue through the selected methods and ease of understanding the method. The other reasons given by the respondents for selecting a specific order of the methods were their closeness to real life, ease of presentation in any place, drawing the attention of the people and the fact that they facilitate self-education. However, some respondents also stated that they did not know; it was boring for them to complete and that they were uncomfortable. In this respect, 52% of the surveyed respondents identified 'advice by talking' as the best method, whereas 33% of the respondents identified it as the second. 33% of the respondents mentioned Drawing as the second most preferred method. 42.9% of respondents identified electronic games as the fourth preference and 47.6% of them mentioned poster/written method as the fifth preference.

The findings further revealed that both male and females identified advising people by talking and drawing as an effective method in comparison to the others. However, there was no significant gender difference for drawing.

6.5 Limitations and recommendations for further research

The results of this study provide information about the road safety messages adolescents preferred and their reasons for preferring them. However, it does not provide information about whether the different methods affect retention, knowledge and behaviour change. Further research is needed to test the effectiveness of the road safety education messages. Also, a considerable proportion of the respondents cited 'I do not know' when asked the reason for selecting their preferred type of teaching method. This suggests that they might have picked up a method based on their attraction for it or even a mere random choice.

6.6 Conclusion

The findings developed through this research suggest the need for creating new educational programmes for adolescents to improve traffic safety. For example, the content analysis of the websites examined for this research was mostly focused on ‘talking’ and ‘films’ while the opinions of the adolescents regarding the effectiveness of these websites helped in understanding their ideas and perspectives on improving traffic safety. This made the findings more relevant, along with being informative because they revealed effective ideas regarding how to educate adolescents regarding traffic risk behaviours and safety that came from an adolescent perspective.

The findings also reveal a critical anomaly. Adolescents are significantly aware of the dangers and risks of using a mobile phone while crossing the road, as revealed from the findings of the experimental studies, but they were still exhibit potentially dangerous road-crossing behaviours in the observational study.

These findings also suggest that the conventional forms of traffic education might not be appealing to them because of the redundant information available on the existing sources of traffic safety information. Hence, there is a need for the development of more creative educational methods to explain the relationship between perceptions of danger and dangerous behaviour. For this purpose, social media can serve to be highly beneficial in educating the adolescents in exciting and informative ways. Under this method, networks can be created with the adolescents and case studies, videos and information about traffic safety can be shared and discussed with them. This will not only help in informing them but also motivating them to practice it in their lives. Such innovative platforms for education are essential for them to acquire knowledge regarding safety while using roads. These conclusions can be further supported by Wicken's Theory that explains that the abilities of an individual to process a set of more than one activity are restricted in nature when there are diminished processing resources present within the person (Harris, 2012).

It has further been examined that the participants were aware of the dangers of looking at the phone, yet they believe that they will be able to manage their electronic devices well while crossing the roads and tend to use mobile phones or music devices to listen to music or chatting on the phone while crossing the road. This can be identified as a form of overconfidence or a kind of hubris in an individual wherein one believes that he or she has the smartness and skill to deal with any accidental situation also and hence, despite being aware of the rules and the risks, they go on practicing the use of mobiles while crossing roads (Ranjan, Fahim and Kirte, 2018).

Wicken's theory implies that the ability to process more than one simulataneous activity is limited when there are diminished processing resources present within the person. The limited processing capabilities of the sensory systems often results in distraction when the individual is engaged with their mobile phone and is unable to process the surrounding environment. In light of this, the findings of this research indicate that new programmes need to be developed to be more imaginative, effective and appealing ways to nudge adolescents to adopt safe road crossing strategies.

In addition to more traditional educational platforms, studies should evaluate the effectiveness of deploying the use of virtual reality, artificial intelligence, digital billboards on crossings (and around the school premises), colourful and informative digital posters on social media websites such as Facebook, Twitter and Instagram to maximise the reach among the adolescents. Moreover, in the contemporary age, teenagers can be observed to be invested in, and influenced by, personal electronic devices using information technology and the internet more than any previous generation. Therefore, the creation of these platforms and devices to create educational programmes is imperative to draw their attention and enhance their knowledge and understanding to improve their road safety behaviours.

Chapter 7. General discussion

This chapter presents a general discussion surrounding the impact of mobile phones on the safety of adolescent pedestrians. The organisation of this chapter enables the study to address the research questions that have been posited in chapter 1. The first section focuses on the first research question: what are the effects of mobile phones on adolescent pedestrians? The subsequent sections are based on the remaining research questions.

7.1 Adolescent pedestrians and mobile phones

The results of the observation study reported in Chapter 3 found that almost one third of the road-crossing activities performed by the students on their way to and from school were executed while being engaged with the mobile phone as well as the music player. Students were seen holding and interacting with the mobile devices in different ways during the crossing, such as texting and listening to music. Additionally, regardless of whether a phone or device was in use, unsafe pedestrian behaviours were frequently observed. This phenomenon of mobile phone usage by adolescents and the levels involved supports previous research that discovered that half of the participants observed in studies were found to use mobile phones while walking to school (Basch et al., 2015; Stavrinos et al., 2009).

When compared to previous research by (Violano et al., 2015), the observation study results reported in Chapter 3 indicate that adolescents use mobile technology more frequently than adults while interacting with road traffic. Violano et al. (2015) observed 17% of total pedestrians using portable technology while crossing a road;

less than the 31.37% of adolescents observed in the observation study of Chapter 3. The differences in the observed outcomes may be due to cultural differences between the United States and the United Kingdom. Further, when considering the observations performed in the study of (Violano et al., 2015), it is important to note that these observations were conducted after the execution of a road safety campaign, which may have encouraged participants to refrain from using their mobile phones. Another explanation is that the road-crossing site used for the observation for this thesis was at a light signal which perhaps gave the adolescents a feeling of safety, so they used their mobile phones more. The following section will discuss the behaviour of adolescents on the road by analysing the possibilities of the occurrence of unsafe activities on the roadside. This is obtained from the findings of a study which suggested that mobile technology has an impact upon the life of adolescents in multiple ways.

7.1.1 Adolescent road crossing behaviour

The observation study results reported in Chapter 3 found that mobile phones and other portable electronic devices distracted adolescents' looking behaviour at the roadside, especially when visual attention to the device was required. This supports previous observations of adults and young people, such as those of (Wells, McClure, Porter & Schwebel, 2018), as well as the results of pedestrian simulator studies, such as that conducted by (Tapiro et al., 2016). The detrimental effects of visual distractions (looking, texting and swiping behaviours) compared to auditory distractions (listening or using headphones) supports the results of previous research into visual and auditory distractions among young people (Downing, Barutchu & Crewther, 2015) . For example, Basch et al. (2015) found that adolescents were more sensitive to distractions than adults, and that stimuli were more distracting for adolescents when in the same modality as the task. Similarly, visual attention to the mobile phone affected looking left and right, but listening behaviour did not. This decrement of visual performance can be explained using Wicken's Theory, which states that the sensory efficiency of a human being tends to be limited due to a shortage of required resources (Wickens & McCarley, 2007). By looking right and left, excess workload is placed upon the visual system, and the efficacy of processing direction-related information is reduced. This theory further assists in clarifying performance-related aspects by suggesting that visual distractions have an impact on behavioural traits that need visual attention, such as the action of observing the roadside by looking right and left. This is burdensome in comparison to behaviours that require auditory attention.

In this research, rates of unsafe behaviours while using phones and other electronic devices were similar to previous studies. For example, (Violano et al., 2015) reported that 42% of pedestrians they observed crossing at intersections on a 'Do Not Walk' signal were wearing headphones, talking on a mobile phone or looking down at an electronic device. In this present study, 35.87% of pedestrians crossing on a 'Do Not Walk' signal were observed with a phone or other device. Furthermore, the individuals that were identified as holding a phone as well as engaging with the device by continuously observing the screen while texting or swiping were identified as less attentive to their surroundings to the left and right prior to crossing the road. Research with adult pedestrians has found similar results for crossing on a ‘Walk ’signal. For example, (Thompson et al., 2013) noted that most pedestrians obeyed the lights, and that distracting behaviour, including texting and using a phone, were not associated with this obedience. It is not clear why safer behaviour is associated with mobile phones for this behaviour category; consequently, further research is needed to investigate the possible reasons. Perhaps pedestrians tend to cross on red due to impatience when waiting for the light to change. If this is the case, then having a phone on hand may give the pedestrian something to do while waiting and, thus, reduce impatient behaviour.

According to Steinberg's dual-processing model of adolescent risk taking (Steinberg, 2010), adolescents are expected to display more unsafe behaviour when interacting with peers. The results of the observation study found that the effect of the presence of other people at the roadside depended on who the other person was. The presence of an adult school staff member did not affect looking behaviour or crossing within the crosswalk but did increase the frequency of crossings on a green (‘Walk’) signal. Although the findings in this research for the presence of other adolescents did not reach statistical significance, those crossing the road alone were more frequently observed looking left and right before crossing than those crossing with peers. As peers can have a positive as well as a negative effect on adolescent risk-taking (Pfeffer & Hunter, 2013), more detailed observations of the type of peer interactions are necessary. According to Evans and Norman (2003), the decision by adolescents to cross the street in a risky manner may be due to viewing the use of a mobile phone or related electronic devices in a positive light, as the adolescents believe that influential people would appreciate and approve of their behaviour. The observation study results show that this area requires further investigation.

The time of day affected safe pedestrian behaviour. Looking left and right was proportionately more frequent in the morning on the way to school and failing to look was more frequent in the afternoon on the way home from school. This reduction in careful looking behaviour might be due to the effect of tiredness at the end of the school day. The role of tiredness in rates of unintentional injuries among adolescents has been noted by previous researchers in several countries, such as China, Korea and the USA (Lam & Yang, 2007; Wheaton, Olsen, Miller & Croft, 2016).

Some of the after-school crossings, however, were safer than those performed in the morning. For example, although the majority of pedestrians crossed on the “green person” signal, a higher proportion of road crossings were made during the “red person” signal in the morning than in the afternoon. Furthermore, although the majority walked within the crosswalk, a higher proportion did so in the afternoon than in the morning. In this regard, the results of this present study support previous research of more unsafe behaviours by Chinese urban child pedestrians in the morning than the afternoon (Schwebel et al., 2018).

The results from this research may have been affected by the presence of school staff members for part of the time in the afternoon, however. For example, students may be more likely to comply with crossing on green and within the crosswalk in the presence of school staff. Another time of day effect was observed in the mornings; those who were late to school in the morning (after 8:30 am) crossed within the crosswalk significantly less frequently and looked left and right less often before crossing. This might be related to inattention to safety concerns while hurrying to get to school.

Reduced mental processing capacity has been correlated with pedestrians ' divergent mental focus on both walking through traffic and use of mobile phones - whether listening to music or talking - according to the Multiple Resource Theory (Wickens & McCarley, 2007). As Wickens and McCarley (2007) noted, the significance of information received, exertion necessary for multi-tasking and negligence while walking may all result in diverted focus in traffic situations. The next section will discuss what adolescents pay attention to in pedestrian scenes.

7.1.2 Allocation of visual attention to pedestrian scenes

The results of the experiment conducted in Chapter 4 showed that a mobile phone did not affect the visual attention of the adolescents from the pedestrian scenes, suggesting that the mobile phone did not distract adolescents within the controlled situations defined in the experiment. This suggests that adolescents are capable of ignoring distractions when asked to focus on the task in front of them, and thus, reminding adolescents to focus on the task of crossing the road could improve their road safety. Furthermore, there is a noticeable differentiation between the scores obtained for pedestrian-relevant changes and the scores that are attained with respect to pedestrian-not-relevant changes. The responses of the adolescents were faster with the relevant changes, signifying that pedestrians are paying more attention and looking more carefully at pedestrian-relevant entities, such as cars and signal lights, when compared to pedestrian-not-relevant changes. This is important for crossing roads safely, and is underpinned by Change Blindness, when a change made to a visual stimulus goes unnoticed by an observer. This is further confirmed by the observation that some participants offered prompts and correct responses for relevant visual elements, such as green lights and cars. They further ignored the unwanted surrounding components like windows and doors, which indicates that adolescents are highly capable in their selective visual attention (Schwebel, Stavrinos, et al., 2012).

In the experimental study detailed in Chapter 4, participants showed a good level of understanding of the risks of using a mobile phone at the roadside. This could explain why they were not distracted by the mobile phone in the laboratory setting. However, understanding the risks is only one aspect of safe pedestrian behaviour; applying that knowledge and understanding can be a challenge in a busy traffic environment. The next section will discuss the understanding of risk results in more detail.

7.1.3 Adolescent pedestrian risk awareness and understanding of the dangers of using a mobile phone at the roadside

Adolescents were questioned about a series of photographs showing an adult standing at the roadside using a mobile phone. They were asked whether they considered it safe or unsafe to use a mobile phone while crossing a road, and to explain their reasons. The majority were aware of the risk associated with using a mobile phone while crossing a road; that is, the majority of respondents reported that it was not safe to use a phone while crossing a road. In the observation study, almost one third of the road-crossing activities performed by the school students on their route to and from school were conducted through the continuous use of a mobile phone and a music player. The results revealed that there was a significant difference in the danger perceptions for different types of phone use. Looking at a phone and listening to a phone at the roadside were identified as the most dangerous activities.

Considering the overall findings obtained from the experimental study conducted in this research, it is probable that adolescents' mobile phone use at the roadside observed in Chapter 3 is not likely to be due to a lack of understanding of the safety or danger of using a phone. Therefore, the data observed through the observation study suggests that holding a particular phone, as well as engaging with the device by observing the screen, texting and swiping, generated lower chances of observing the surrounding environment by looking left and right. Moreover, other types of behaviour associated with the mobile phones, such as speaking and/or listening (either by holding the phone to the ear or using headphones), did not affect the actions of looking left and right. Adolescents deemed looking at the phone the most dangerous behaviour, and yet this was one of the risky behaviours they often engaged in during the observation study. Participants also believed that listening to the phone was dangerous, yet many adolescents listened to the phone during the observation study.

Reasons given by the adolescents for deciding that crossing a road was not safe were road sites (red person light signal, green person light signal, no light signal) and mobile use while crossing a road (holding phone, listening to the mobile phone, looking at the phone, no phone use). For holding a phone, the majority of adolescents said that it was safe to cross the road while holding a mobile in the hand at a red light. They considered that solely keeping the phone in hand was not a distraction, while in the observation study, adolescents were distracted by using a mobile phone when looking at the screen or texting/swiping. As per the findings acquired in the results shown in Chapter 3, it has been deduced that the road crossing activities performed by pedestrians by having a phone or any other electronic device resulted in reduced chances of observing the roadside scenario by looking both left and right when compared to the individuals who did not use any electronic device or phone. These findings highlight unsafe situations while using mobile phones during roadside crossing, and further, when considering the understanding of danger, findings revealed that activities such as hearing and looking at the mobile phones resulted in "not safe” responses. In addition, having no phone during road crossing generated the lowest number of "not safe” data responses.

The main inference from this study is that adolescents are aware that the use of mobile phones while crossing the road is highly dangerous. However, the level of understanding of adolescents surrounding the dangers associated with phone distractions are unclear. Participants responded that the level of distraction was less when the light signal was green. However, in the presence of the light signal, the adolescent was distracted more by the signal in comparison to the phone. Further, by keeping the mobile device in hand, the possibility of using the phone while waiting for the green signal was raised.

Risk-taking behaviour is dependent on cognitive development levels (Steinberg, 2010). According to research by Chinn et al. (2004), adolescents feel confident about their abilities to cross the road, suggesting that there are fair chances that dangerous road scenarios could be underestimated. Alternatively, adolescents may also simply fail in the implementation of the knowledge or skills they possess.

7.1.4 Self-regulation, risk-taking and experience of using mobile phones

Self-regulation (long-term and short-term), risk-taking (as measured by BART) and experience of using mobile phones were investigated for their association with visual attention to pedestrian scenes as well as recognition of pedestrian mobile phone danger scores.

Theoretical models, such as Steinberg's Theory of Dual Processing, can be referred to for an explanation as to why risk-taking attitudes in adolescents is high, and why they are more prone to engaging in risky situations (Steinberg, 2010). Despite the fact that adolescents possess the ability to think in abstract terms and judge risky situations, they do not always employ these abilities adequately. In addition, the psychological factors affecting their behaviour such as peer pressure, impulsivity and emotional immaturity can override cognitive understanding of risk (Bonnie et al., 2015).

It was observed in the study that the Balloon Analogue Risk Task (BART) and self-regulation were not correlated. Adolescents' "safe"/"not-safe" decisions were not related to risk-taking or self-regulation. This suggests that these variables do not result in individual differences in road safety awareness. Although there was no significant association found in this study between self-regulation and risk-taking, other researchers have found relationships between these variables. For example, Magar et al. (2008) study into adolescent students measured emotional regulation, cognitive regulation and risk-taking. The findings revealed that there was a positive relationship between poor cognitive self-regulation and endorsement of risky activities. This research asserted that indulgence in inadequate emotional regulation predicts higher participation in risky behaviour, which might also include activities such as the use of mobile phones while crossing roads ((Boyer, 2006; Magar et al., 2008). Further studies are needed to verify the relationship between these variables.

7.1.5 Age

On the basis of the findings in Chapter 4, there is no significant difference between age groups for the different danger-related conditions of distraction. There was no significant age difference between pedestrian-relevance and distraction-related danger results or conditions. The study of Tapiro et al. (2016) discussed in Chapter 2 found no statistically significant differences between age groups in regard to cell phone distraction, which support the results of this study. Further, for both age groups and all types of phone use, adolescents believed that the most dangerous activities were listening and looking, while the least dangerous were holding and having no mobile phone. There was no significant interaction between age and type of mobile phone use.

Although there was no significant association with age found in Chapter 4, previous research by Tolmie (2006) found a difference in cognition between the ages of 11 and 15 years, in which adolescents became more consistent at safe route planning as they got older. However, there is limited information in the prevailing literature regarding pedestrians older than 14 years (Tolmie, 2006). Magar et al. (2010) found that adolescents between the ages of 11 and 17 do not practice a strategic approach to utilising visual information while crossing roads. This might point towards a deficiency in attention.

As per Steinberg's Dual-processing theory, or model of adolescent risk-taking, adolescents are expected to display more unsafe behaviour during the performance of an interaction with peers (Steinberg, 2010). In support of this theory, behavioural analysis of individuals aged between 10 to 30 years signifies an increment in sensation-seeking and risk-taking during the middle years of their adolescence (Strang, Chein & Steinberg, 2013). In this regard, the t-test result found no significant difference between age groups in risk taking, as measured by BART. The results therefore confirm that risk taking is lower in adolescent groups, in contrast to Steinberg's predictions.

Additionally, the Balloon Analogue Risk Task (BART) and chronological age were not found to be associated. Therefore, on the basis of the above results, it can be expected that self-regulation among adolescents improves as they age and mature.

7.1.6 Gender

The observation study reported in Chapter 3 explored gender differences in phone use and related pedestrian behaviours. The results found that rates of electronic device use were proportionately higher for female, compared to male, pedestrians, with 58.03% of female pedestrians observed with electronic devices and 33.59% of males. One possible explanation for this is the phenomenon of peer effects, in which the female depends on her friends to look at the road while she uses her mobile phone. Although females used their phones more often, there were no gender differences in unsafe road crossing behaviours. This does not support the gender differences noted in field studies of adult pedestrian behaviour (Hatfield & Murphy, 2007; Wells et al., 2018) .Only seven out of 39 males did not look at the traffic while crossing but looked at the traffic signal to decide whether or not to walk.

Three of these males were talking on the phone (Hatfield & Murphy, 2007). Pai (2017) and Stavrinos et al. (2011) found that female participants were more likely than male participants to perform all unsafe crossing behaviours, but there were no significant differences. Gender differences have been reported in young pedestrians' injury rates and unsafe behaviour (Nasar & Troyer, 2013; Peden et al., 2009) with males having higher injury rates than females. Furthermore, Hatfield and Murphy (2007) found that female pedestrians walked more slowly while crossing using phones when compared to males. Additionally, study findings also highlighted that females are less likely to wait for traffic to stop while crossing the road using phones when compared to males. The apparent gender disparity found in previous studies was also evident here in the observations of road-crossing behavior in chapter 3.

There are, however, a lack of gender differences for correctly identifying changes in pedestrian scenes. Further, no gender differences are observed in the response times associated with this task. Therefore, males, as well as females, are capable of allocating their attention towards the changes introduced in pedestrian scenes, suggesting a gender difference for attention-based tests cannot be expected. The pattern for detecting pedestrian-relevant and non-pedestrian-relevant changes do not vary between males and females.

Finally, there were no gender difference differences in understanding the dangers related to the use of mobile phones along the roadside. It can be inferred, therefore, that the results obtained in this current study support the results of (Hatfield & Murphy, 2007) which reveal that adolescents deem it safe to cross when listening to or looking at to a mobile phone at a green light. In this respect, it was found that there was a significant difference between the thinking of adolescents regarding the usage of mobile phones in different conditions, regardless of gender, as the results revealed no significant difference in the risk-taking behaviour between different gender groups.

7.1.7 Road safety education

The intention of Chapter 5 was to undertake a content analysis to evaluate whether mobile phone use advice is included in UK- government and non-government agencies' online platforms, focusing on educators, parents, adolescents and teachers. The results identified that only seven of all selected websites involved information relevant to the distraction of pedestrians due to electronic device usage. There are a very limited numbers of websites that contain information regarding mobile-phone distractions, as well as electronic, device-based distractions. The results of Chapter 2 found a lack of studies surrounding mobile phone distractions to pedestrians, thus no specific educational programmes are recommended.

Further results detailed in Chapter 5 found that the general format most often used by websites involves lesson planning and campaigning. The most frequent type of teaching and learning materials were film or video and activities such as talking and discussion. The results of Chapter 6 showed that one of these activities - talking, was the method most often mentioned by the sample of adolescents, and the opinions of a small group of adolescents about road safety education materials was reported. Two principal themes can be drawn from this analysis: firstly, that "advising by talking" was considered to be the most effective method, with the majority of adolescent respondents identifying this method as more effective in terms of gaining knowledge and information about road safety and avoiding the use of mobile phones while crossing roads. When ranking each method out of a list provided, the majority of the respondents identified the advising and talking method as their first preference. Ways of talking to convey information on road safety were mentioned as the first preference by the combined group of males and females, however a more in-depth analysis revealed that more females than males mentioned this as their first preference. There were many links provided on each site (for example, the “THINK” site is linked by many of the 40 sites studied, but the information provided is not focused on distractions; rather, it highlights more generally on road safety for young people). However, it would be better to focus on adolescent-pedestrian road safety in order for the message to be clear and easy to understand.

Further, a book by the International Transport Forum (2016) highlights that a motivation-generating strategy can serve as useful in guiding people about traffic safety issues because it offers the most effective guidance and advice. It also ensures coordination and cooperation among people in ensuring the application of road safety norms and hence has a higher probability of generating positive outcomes.

The second key theme identified in this regard is that adolescents prefer a method of gaining information about road safety which is more convincing and offers more of an explanation, stating, "I can convince them, and it is easy to understand”. This theme can also be studied in light of the prevailing literature; according to (Peden et al., 2009), advising through talking is a useful method of spreading road-safety education and awareness because it can include the use of drawings, illustrations, leaflets and brochures, thereby helping people to retain deeper information for longer, making this method more effective for road safety education (Peden et al., 2009). However,(Pettorino, Giannini & Chiari, 2010) highlight that the manner of communication and tone of advising must take care not to appear as though the information about road safety is being thrust upon the audience; there must be a clear and effective explanation about the issues and outcomes associated with negligent behaviour on the roads, and how road safety practice can be useful in preventing fatalities caused by the use of mobile devices in the streets (Pettorino et al., 2010). Hamilton (2016) asserts that the method of advising has a higher potential to convince, which makes it an effective method of aiding understand and bringing needed behavioural changes. It also allows for two-way communication, which further helps in raising the awareness of road safety more effectively and in a more long-lasting manner for the audience (Hamilton, 2016).

Two given examples, the first one termed “Road Ready” and featuring a children's television presenter, and the second with drawings made by a young artist can influence the perception of participants, who may be influenced by the viewpoints of the adolescent presenter or the appealing drawings. This can be further attributed to the peer group influence concept, which is related to safe as well as risk-generating behaviour (Pfeffer & Hunter, 2013). Furthermore, it is also interpreted that celebrity figures, such as the children’s television presenter, can influence younger individuals.

In this respect, Chapter 6 reported data on the method adolescents deemed most effective by ranking the methods and information types in order from the most effective (i.e. those that discouraged mobile usage on the road), to the least effective. The findings obtained were analysed with the help of the descriptive analysis method.

Results showed that the most frequent reasons quoted by respondents regarding the choice of the methods for obtaining education on road safety were: the ease with which it can convince the individual, and whether the information can explain an issue through the selected method and how easy it is for them to understand the issue through the selected method. Respondents also stated that the selected method should be close to a realistic presentation of life, able to be utilised in any place, more attractive in order to draw attention of the people and helpful in self-education. Some respondents, however, also stated that they did not know. In this respect, 5%, 5%, and 9% of respondents voted for the reasons ‘I can convince them’, ‘I can explain more ’and ‘easy to understand’ respectively. About 9% of the respondents gave‘ I do not know ’as the key reason.

With regards to the second question, which asked participants to rank five examples of road safety messages, some respondents also stated that they did not know, it was boring for them to complete or that they were uncomfortable. Just over a half, 52% of the surveyed respondents, identified 'advice by talking' as the best method, whereas 33% of the respondents identified it as the second. Another 33% of the respondents mentioned drawing as the second most preferred method, while 42.9% of respondents identified electronic games as the fourth preference, and 47.6% of respondents mentioned posters or written methods as their fifth preference. Furthermore, both males and females identified advising people by talking and drawing as an effective method in comparison to others. However, it was found that females ranked examples of ‘talking ’and ‘drawing ’as significantly more effective than males did.

The method on which the website-based messages were focused has been aligned with the method preferred by adolescents while crossing the road to some extent, as it stressed the importance of focus and concentration on the roadside, which may explain the ranking of the methods. Furthermore, the approaches that are utilised by websites, such as an attractive webpage, information links and interactive or responsive pages for distribution of the safety message across the adolescent population were not similar to the preferred method of the adolescents, as the websites were incapable of offering adolescents advisory support.

The results of studies 5 and 6 may therefore be used in creating intervention programs that are inspired by the adolescents themselves. The use of traditional programs such as posters may not be as effective as they have become too familiar.

7.2 Limitations and recommendations for further research

This thesis used a range of methods, including systematic literature review techniques, content analysis, experimental techniques, observation methods and adolescent opinion gathering approaches, such as the interview for drawing data about factors leading to risks that can be encountered by adolescent pedestrians and the impact of electronic devices on pedestrian behaviour. However, this study has focused on UK adolescents, so findings obtained from the observation study, experimental methods and the adolescent opinion study cannot be applied to the generalised context, encompassing different cultures and depicting factors relating to cultural influences on the pedestrian behaviour of young individuals. It would be fruitful for future investigations to focus on different research settings other than the UK and select a different age group to produce comparative results. The rules of road safety, as well as safety-related norms, are different in distinguished cultures; in future, experts/academics in this field could explore a variety of factors - in addition to the use of electronic devices - that are responsible for distracting pedestrians and intensifying the issue of injury and road accidents.

The systematic review found that there were few studies surrounding adolescent mobile phone use while crossing the road, and that this was important for organising educational programs. One of the key limitations of this review is that the majority of the studies (14) selected were conducted in the same local culture of the USA. For this reason, it is difficult to extrapolate and generalise findings to other countries. There is a need for future studies to include a wider range of cultural contexts, due to the fact that driving and pedestrian behaviour is strongly linked to cultural norms. Furthermore, it would be appropriate to conduct an updated systematic review comprising the recently published sources of secondary data. There have been a large number of new studies published regarding road safety education as well as precautionary measures for pedestrians since Chapter 2 was completed in 2018.

While performing the research work with adolescent groups, several problems were encountered, such as acquiring access to educational institutions and schools. Some school authorities did not allow research on their premises and refrained from allowing student participation. However, after understanding the academic purpose of the research, permission for this research was often granted. Further, problems surrounding the access of the right sample size were identified. The majority of students were also not allowed to use mobile phones within school premises.

From the limitations of the observation study reported in Chapter 3 is that observations were conducted at only one type of pedestrian crossing site at one school location. In future, therefore, adolescent pedestrian behaviour could be observed and assessed with a focus on mobile phone distractions with reference to different sites and locations. Furthermore, the road had a slight curve, which may have affected pedestrian behaviour. Additional research is needed into adolescent pedestrian behaviour and mobile phone distraction at different types of sites, particularly those with no traffic controls. Further observations at different times of day would be beneficial, particularly in the afternoons when students are more likely to be exiting school en masse. As pedestrians were not filmed for ethical reasons, fewer observations were made in the afternoons as the majority of students left the school premises at the same time, making live observations difficult in contrast, arrival times were more staggered in the mornings. Additionally, observations were overt, and the researcher was clearly in view of the pedestrians, which could have affected their behaviour.

A further limitation resulting from the restrictions on filming young pedestrians is that it is possible that the same pedestrian was observed on more than one occasion. Consequently, our data should be interpreted as observations of crossing events rather than the behaviour of individual pedestrians. Although fairly detailed information was obtained about how the adolescent was using the phone or another electronic device, information about safe and unsafe pedestrian behaviour was limited to three categories of behaviour. Other behaviours that could be added to the observation would be waiting time and whether the pedestrian stopped at the kerb before crossing. As the school had a high proportion of students from low-income families, it is possible that our results represent a conservative estimate of adolescent pedestrian phone usage. This affected the observation-based studies, which required an assessment of the student's behaviour in using mobile phones during walking. This further assists in inferring that the observation study is identified as affected by this, as it had underestimated the number of adolescents that may be sufficiently capable of utilising the phone on the roadside.

One limitation of the experiment reported in Chapter 4 was that the mobile phone used in this study was not actually the individual participant’s own phone, which may have influenced the effect on their attention. Further, the mobile phone distraction used was a ‘funny’ film, which was both visual and auditory. This method was decided upon as this would be the usual way for teenagers to use their phones to see a film clip. The visual distraction of the film was intended to disrupt the allocation of attention, as it utilised visual resources. Meanwhile the auditory distraction of the film was not expected to disrupt the allocation of attention as it used different resources, according to Wicken’s theory. What could have happened is that participants heard the sound of the funny film but were not distracted enough to look; if the distraction had been visual without sound it may have been more distracting.

Future research could be pursued by focusing on parents’ views of the road safety of their children. The experimental study highlighted that safe decisions of school students was not linked with mobile ownership, risk taking, gender, age or self-regulation. Results illustrate that these variables do not lead to individual differences in road safety awareness and pedestrian behaviour, so there is a requirement for further research to determine and examine other individual factors leading to distraction issues and pedestrian injury.

Some of the limitations of the two studies on road safety education include small sample sizes and the availability of resources. The main limitations of this study are that, of the sample size of 40 websites, only six contained advice for adolescents about distractions by using a mobile phone and other electronic devices, which is small in comparison to previous studies which focus on highlighting diverse strategies of offering road safety learning and improving the attention level of pedestrians by reducing mobile device-related distractions. It is therefore suggested that future studies use primary methods like semi-structured or telephone-based interviews for gathering related information from officials of road safety education, parents and teachers regarding their capability to offer required road safety learning to adolescents and the type of resources utilised for safety training measures.

One of the key limiting areas of the study is linked to the adolescent opinions study, as participants were initially asked to rate the most effective method among the available examples of the given five. Further, the consideration of a specific method is offered on the basis of ranking; the choice of method for gaining information and increasing awareness of road safety is solely based on participants' knowledge levels surrounding the different sources of data, such as internet and secondary material.

Importantly, the explanation of adolescent risk-taking behaviour generates suggestions for future work related to parenting culture, as adolescents follow the habits and behaviours of their parents. Adults occasionally break the rules as they have enough experience to cross the road and perform other activities simultaneously, such as talking while crossing the road, which may prove difficult for younger individuals.

7.3 Recommendations for road safety education

1. There is a significant need for road safety training surrounding the dangers of using mobile phones while crossing the road to be given to pedestrians. The rationale for this is based on the following points:

    a. The systematic review found that pedestrians are at risk of injury when crossing the road while using their mobile phones.
    b. The observation study found that adolescents frequently use their mobile phones and other electronic devices when crossing the road.
    c. The observation study also found that adolescents perform risky road-crossing behaviours when using their devices.
    d. Some adolescents are not aware of the risks of holding phones during road crossing.
    e. Adolescents need to be guided in a way that enhances their concentration on roadsides as opposed to mobile phones while crossing roads.

2. There is a need for separate and distinct programmes about distractions of mobile phones for pedestrians, wherein the risks should be highlighted and

guidelines on safely crossing roads should be delivered (Colucci & Meléndez, 2014).

3. Adolescents should be targeted for raising road-safety awareness about mobile phone distractions. Moreover, messages related to the adverse impact of mobile phones in causing accidents should be highlighted.

4. Chapter 6 indicated that adolescents preferred advice by talking and showing films to learn about road safety. It is recommended that safety-advice based messages for adolescents should be given via the medium of film in order to obtain attention and should be followed up with talking about the issues raised in the film and discussion.

5. Although there were few gender differences in pedestrian behaviour, attention, or understanding of risk, females were found to use their phones at the roadside more often than males. Furthermore, females preferred a different form of road safety message to males. Different messages might therefore appeal to females more than males which should be taken into consideration when designing road safety education.

6. It is also recommended that legislative norms are enforced in countries like the United Kingdom for restricting the use of hand-held mobile devices during walking on the road and limiting the use of any of the distracting electronic devices (GOV.UK, 2020).

7. Distribution of a short report to schools about adolescent pedestrian behaviour when using mobile phones. The school newsletter (see Appendix 3.3) shows that the school involved in the observation study valued the report they received from the researcher and has repeated the safety message to parents and students through the school website and newsletter.

7.4 Conclusion

This conclusion section summarises the findings in relation to the main research questions formulated, detailed as follows:

Research Question 1: What are the effects of mobile phones on adolescent pedestrians?

Based on the reviewed findings, it is noted that some adolescents are affected by mobile phones due to looking at the screen and continuously texting. With respect to the systematic review of the literature, it was found that pedestrians are more likely to engage in unsafe road behaviour when using mobiles or headphones. The observation study data found that females used mobile phones more than males; however, there was no distinction in the level of unsafe behaviour shown by both males and females linked to the usage of mobile phones during road crossing. Adolescents believed that looking and listening to a phone at the roadside was more dangerous than holding a phone, yet a large proportion of adolescents thought that listening to the phone at the roadside was safe.

Research Question 2: Are some adolescents affected more than others?

There were no age or gender differences in the effects of mobile phone distraction on adolescents' attention to pedestrian scenes. Furthermore, there was no relationship between attention to pedestrian scenes and self-regulation or risk taking. When observing road-crossing behaviour, there were no gender differences in risky behaviours, although females more often used a phone at the roadside than males.

It is noted that the observed opinions differed depending on gender. For instance, male adolescents were more positively affected by the opinion of advisors talking to them about reducing the risk of accident during road crossing with mobile phones than their female counterparts. Furthermore, when reviewing the findings of the experiment, it is noted that age and gender do not have significant interaction and relation to the use of a particular category of mobile phones; thus, no specific effect on adolescents in this respect has been retrieved. Moreover, while giving attention to the pedestrian scenes in the experiment, it was observed that some adolescents consider it safe to perform road-crossing activities with a mobile phone in the case of a green signal. Some adolescents, however, were well aware of the risks being taken, and determined the need for concentration on both roadsides while crossing the road while having a mobile phone in hand. Self-regulation was therefore maintained by some adolescents by considering the dangers of utilising mobile phones at the roadside. There were no differences in the effect of the mobile phone on attention to pedestrian scenes.

Research Question 3: How can road safety education for adolescent pedestrian mobile phone users be improved?

With regard to this question, findings from the study have been summarised below. When considering the content analysis, it was noted that the majority of road safety organisations' websites did not provide any advice or information about distractions from mobile phones or other electronic devices for children and adolescents in pedestrian situations. It can be inferred, therefore, that there is a need for increased adolescent awareness of these risks through websites and personalised messages for improving risky pedestrian behaviour and limiting the use of mobile phones in pedestrian situations.

As a whole, it is deduced that oral communication is a useful way to educate pedestrians about potential negative implications of using mobile phones and electronic devices during a variety of pedestrian situations.

This research found an adverse effect of electronic distractions on adolescent pedestrians. In this respect, previous research has shown that there has been an increase in pedestrian injuries over the last few years (Schick, 2014). Among people below 31 years of age, there are greater levels of injuries associated with the use of mobile phones and headphones around traffic. This has been emphasised by the National Centre for Injury Prevention and Control (2009), with greater hazards due to distraction through mobile phone use being associated with young people's enthusiasm for mobile phones. This hazard is substantial as the instances of distracting mobile phone use during road crossings was found to be as high as 22% for High school students, as well as 12% for Middle school students (Schick, 2014).

Previous researchers have shown the kinds of distracting activities that affect pedestrian safety include listening to music, texting and calling on a mobile phone during walking. As Lin and Huang (2017) stated, walking across a street and taking other risky actions may be affected by the distraction of mobile phones, potentially resulting in a collision, harm and even loss of life. Byington and Schwebel (2013) that diverted attention from the street for a greater duration of time, fewer glances to the right and left, slow responses to safe opportunities to cross the road, a missed chance to walk, pausing before walking across a street for a longer time and a greater chance of a collision or near-collision with traffic have all been associated with pedestrians whose attention is taken by mobile phones. These findings are underpinned by the study of Docan-Morgan (2019), which found that on the occurrence of more than one concurrent activity, available resources are limited, and there are higher chances of error due to diminished processing abilities. This phenomenon results in the generation of risky behaviour among pedestrians while crossing the road, as attention is diverted by an external entity. As Hatfield and Murphy (2007) emphasised, mental focus is necessary while walking across a road.

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Appendices

Appendix 3-1: Check list sheet for the observation study

Day ………………… ……………. school: ……………………time …………
…………. weather: …………… ……..

Student	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Alone F/M															
With one FF/MM															
With group FF/MM/ MIX															
Age Same/Adult/Child/MIX															
Hold mobile Only															
Hold mobile Look															
Hold mobile Use finger															
Hold mobile															

speaking															
Hold mobile EAR															
Headphones															
Without device at all															
Walk diagonally															
Walk straight															
Look right/left															
Look one way															
Do not look at all															
Cross on red/green															
Press button															
Walk / run															

Appendix 3-2: Abstract published study

A version of Chapter 3, the observation study, was published in Safety, and the study was placed on the cover of the Journal.

Baswail, A., Allinson, L., Goddard, P., & Pfeffer, K. (2019). Adolescents' Mobile Phone Use While Crossing the Road. *Safety*, *5*(2), 27.

Phones and other portable technology can be a distraction for pedestrians, affecting their ability to cross a road safely. This study focused on adolescents and investigated whether using a phone distracts attention while crossing the road. A field observation outside a secondary school in the north of England was carried out over a four-week period in 2018 with permission from the school. Observations included recording what accessories the pedestrian was carrying (phone, headphones or another electronic device) and their associated action (whether they were holding the device, speaking into a phone, looking at it, holding it to their ear or interacting with it manually). We observed whether the pedestrian looked (or failed to look) left and right before crossing the road, whether they crossed when the pedestrian light was on green or red, and whether they crossed within the cross-walk. We found that 31.37% of road crossings were made by adolescents with a phone or other device. They looked left and right before crossing less frequently when they had an electronic device with them, when looking at the screen and when texting or swiping. In conclusion, the safety of adolescent pedestrians is affected by mobile phones and music players

Appendix 3-3: Extract from school newsletter

Extract from Trinity Weekly, Vol 35, No. 26, page 3, and featured on the school news website with the title Road Safety: https://www.trinityhigh.com/news/road-safety-4/.

“Recently, we had a PhD student from the School of Psychology at Lincoln University researching the crossing outside of school at the beginning and the end of the school day. Over 4,000 observations of crossings were made over an 8 weeks period and a report was handed to me by the researcher, Amal Baswail. Its main recommendation was a simple one; "remind students about the dangers of using a mobile phone when crossing the road". We will be stressing this in school in forthcoming assemblies - it is an important 'keeping safe' issue when crossing any road, not just travelling to and from school.”

Appendix 4-1: Demographic form for the experimental study

Demographic questionnaire and phone use questions

How old are you?.............

Gender

Boy….

Girl….

Which school year are you in?............

Do you own a mobile phone?

Yes….

No….

Do you own a ‘smart phone’ (a phone with internet and apps)?

Yes….

No….

When did you get your own first mobile phone?

…………………………………………………………

Appendix 4-2: Change photographs answer form

Are there any differences between the photographs or not? If so, what are they?

Photograph	Yes	No	Answer time	What are the differences?
1	☐	☐		
2	☐	☐		
3	☐	☐		
4	☐	☐		
5	☐	☐		
6	☐	☐		
7	☐	☐		
8	☐	☐		
9	☐	☐		
10	☐	☐		
11	☐	☐		
12	☐	☐		
13	☐	☐		
14	☐	☐		
15	☐	☐		
16	☐	☐		
17	☐	☐		
18	☐	☐		
19	☐	☐		
20	☐	☐		

Appendix 4-3: Safe cross answer form

Do you think it is safe for him to cross or not? and why?

Photograph	Yes	No	Why?
1	☐	☐	
2	☐	☐	
3	☐	☐	
4	☐	☐	
5	☐	☐	
6	☐	☐	
7	☐	☐	
8	☐	☐	
9	☐	☐	
10	☐	☐	
11	☐	☐	
12	☐	☐	

Appendix 4-4: Risk- taking (BART)

Tour	Time	Result	Clicks
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Appendix 5-1: Coding sheet for the content analysis study

Organisation & their website: ………………….

Type: ……………. Name:.............................

What is the message?....................

	Distraction type					Who is the training for?				Who is using this information?			Type of road user		
	Phone	iPad	Mp3 / music player	Electronic device	Headphones	Child/ 5-10/ primary /key stage 1 or 2	Adolescent / 11-18/ teenagers/ secondary school / key stage 3 & 4	Child or children (no age) / young people	KS / student	Teacher	Parent	Child	Pedestrian walking/crossing	cyclist	Scooter / skates
Materials & resources															
Posters/infographics															

Music															
PowerPoint															
Statistics															
Audio clips															
Video/film/ DVD															
Game/games															
Story															
Photo															
Toys															
Test/quiz															
Report															
Website															
Book															
Activities															
Take out															
Speaker (e.g. police speaker)															

Discussion															
Play games															
Drama /theatre in education															
Reading															
Ask questions															
Visit															
Watch															
Practical/practice															
Presentation															

Appendix 5-2 Definitions of the important variables used in this study

Type of information were defined from a Macmillan dictionary
(Sutherland,1995).

Game

1- Definition of terms: An activity that one engages in for amusement or fun.
2- Example of operational definition: 'the kids were playing a game on road safety.'

Play

1- Dictionary definition: "*Engage in activity for enjoyment and recreation rather than a serious or practical purpose*".
2- Operational definition*: The children were playing with a cycle.*

Teach

1- Dictionary definition: Give information about or instruction in (a subject or skill).
2- Operational definition: for example, '*He came one day each week to teach driving.'*

Educate

1- Dictionary definition: "*Give (someone) training in or information on a particular subject".*
2- Operational definition: *"a plan to educate the young on the dangers of roads".*

Learn

1- Dictionary definition: "*Gain or acquire knowledge of or skill in (something) by study, experience, or being taught".*
2- Operational definition: *'They'd started learning how to cross the road.'*

Course

1- Dictionary definition: the way in which something progresses or develops.
2- Operational definition: *the road safety course.*

Training

1- Dictionary definition: *"The action of teaching a person or animal a particular skill or type of behaviour".*
2- Operational definition: *"in-service training for staff or student on road safety".*

Lesson

1- Dictionary definition: a period of learning or teaching.
2- Operational definition: *"in-service lesson for school about road safety".*

Exercise

1- Dictionary definition: a task set to practise or test a skill.
2- Operational definition: "*exercises on road safety".*

Activity

1- Dictionary definition: a thing that a person or group does or has done.
2- Operational definition: *the road safety activities.*

Quiz

1- Dictionary definition: "*a test of knowledge, especially as a competition between individuals or teams as a form of entertainment".*
2- Operational definition: road safety test.

Discuss

1- Dictionary definition: Talk about (something) with a person or people.
2- Operational definition: "*I discussed the matter with my student".*

Presentation

1- Dictionary definition: *"a speech or talk in which a new product, idea, or piece of work is shown and explained to an audience".*
2- Operational definition: *a class presentation on road safety.*

Event

1- Dictionary definition: "a planned public or social occasion".
2- Operational definition: *"Staff have been holding a number of events to raise money for a walk event".*

Advice

1- Dictionary definition: "*guidance or recommendations offered with regard to prudent future action".*
2- Operational definition: *"My advice is to switch your mobile off while you are driving".*

Rule

1- Dictionary definition: "*a principle that operates within a particular sphere of knowledge, describing or prescribing what is possible or allowable".*
2- Operational definition: *'the rules of grammar on road safety.'*

Guide

1- Dictionary definition: "a book, document, or display providing information on a subject or about a place".
2- Operational definition: *"a sports quiz on road safety".*

Poster

1- Dictionary definition: "a large printed picture, notice, or advertisement displayed in a public place".
2- Operational definition: *"a poster campaign on road safety".*

Video

1- Dictionary definition: a recording of moving visual images made digitally or on videotape.
2- Operational definition: *"They sat down to watch a video on road safety".*

Film

1- Dictionary definition: a story or event recorded by a camera as a set of moving images and shown in a cinema or on television.
2- Operational definition: *"a ghost street film about road safety".*

Distractions types:

1-Phone, cell phone, mobile phone, smart phone.

2-iPad/iPod

3-mp3/mp4

4-Other: radio, sound, peer, friends, weather, music, headphone.

Training/ education for:

1-Child (0-11 years)

2-Adolescent (12-18 years, teenager)

3-Age not specified (children, young)

4-Key stage 1, 2, 3 (student, pupil, primary school, secondary school, class)

Who is using the advice or information:

1- Teacher: to educate the student
2- Parents: to educate the child
3- Child
4- Other: not specified, police

Type of road user:

1- Pedestrian: walking, crossing
2- Cyclist
3- Scooter, sledge
4- Others: Go to school, driver, general road safety

Appendix 6-1: Coding Sheet for the adolescent opinion study

1. Can you think of any ways of providing information about the risks of using mobile phones that are effective and useful in getting adolescents to avoid using mobile phones on the road? If so, 'what are they and why?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
……………………………………………………………………………………………

2. Please rank the methods/types in order from the most effective and useful in getting adolescents to avoid using mobile phones on the road to the least.

1- ……………………………………………………………………… Why?.........
2- ……………………………………………………………………… Why?.........
3- ……………………………………………………………………… Why?.........
4- ……………………………………………………………………… Why?.........
5- ……………………………………………………………………… Why?.........